Classroom Computer News

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MICRONEWS

- The combined retail value of microcomputer shipments to educational institutions will exceed one billion dollars from 1980 to 1985, according to Creative Strategies International, a California market research firm. The firm expects the share of the total market for microcomputers going to education to more than double over the period.

- Within five years, every freshman at Carnegie-Mellon University in Pittsburgh, Pa., will receive a microcomputer as part of the university's orientation program, reports *Computerworld.* The goal? Computer literacy for the fine arts major as well as for the computer programmer.

- SIGI, a widely used computer-based career guidance system developed by the Educational Testing Service, has been converted to run on a Radio Shack TRS-80 Model II computer. Radio Shack has announced an agreement with ETS to provide computers to colleges and universities licensed to use the system.

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Courtesy of Control Data Corporation

Control Data Corporation's PLATO Basic Skills is the 3 R's delivered on a sophisticated computer system. How well does it work?

Dynamite! Super! No Way! What We Can Learn from CDC's PLATO

by Jeffrey Nilson

David is a sprightly sixth grader with wavy dark hair who is wearing a black sweat shirt with USA written across the front. He is sitting like a coiled spring in front of a Control Data PLATO computer terminal, doing a lesson on fractions.

"In school I'm having trouble with subtracting fractions with different denominators," he says.

After he finishes reviewing adding fractions with the computer, he chooses a tutorial on subtracting mixed numbers.

He touches the space marked "Tutorial," the terminal beeps, and the screen clears, leaving a message: "Wait a minute while I go find Clever." Clever is one of the characters that helps teach lessons in the Control Data Basic Skills Curriculum, which is what David is working through. Clever is a box with legs. In the middle of the box is a smile, which enables Clever's torso to double as its face.

At the beginning of the lesson, Clever shows how to subtract the bottom fraction from the one on top.

"Think 5 . . . Take away 1/3." Hopping back along a number line on the bottom of the screen, Clever shouts, "Look where I stop."

"I don't get it," David says.

The computer presents several examples, which David does parts of. He figures out how to subtract the bottom fraction as long as the denominators are the same.

"Super! Dynamite!" Clever exclaims.

Then printing 7 - 3 1/4 in large numbers, the computer invites David to "try this one." David looks at the screen and folds his arms. "I don't know this at all,"

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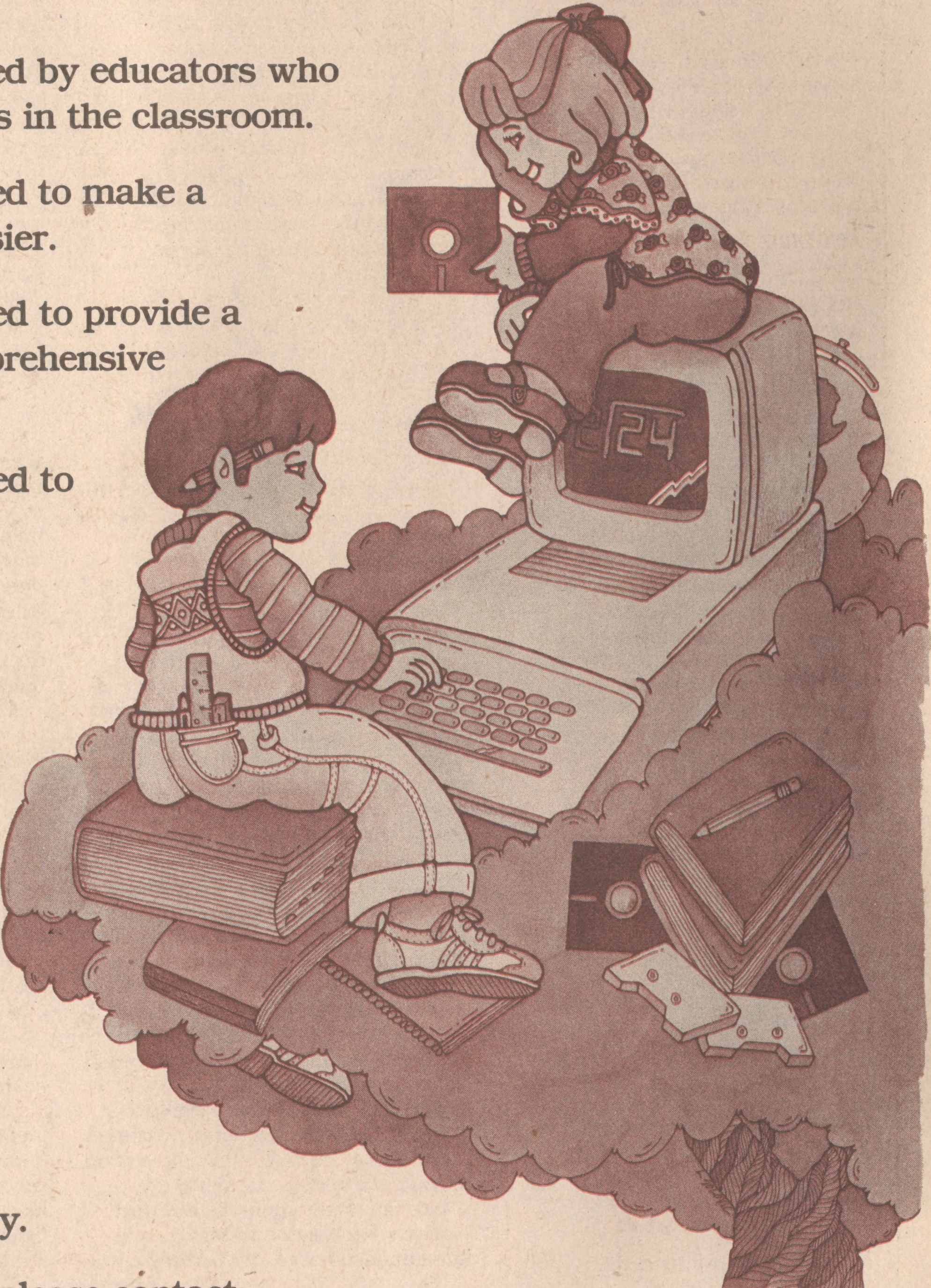

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FORUM

A Voice for Optimism

by Lloyd R. Prentice

A striking theme runs through conferences and conversations about microcomputers and education—problems. A dinner speaker at a recent conference cited, among other problems, the prejudice and fear that many teachers have toward the computer, the danger of students losing basic skills, the magnification of individual differences as students learn at their own paces and the social equity problems that arise out of unequal access to computers.

We all know that these problems are significant. But such problems should be seen as stepping stones toward opportunities. The computer opens vast new horizons for educators—opportunities that far exceed the problems.

Higher-Level Teaching

The first opportunity is the chance to redefine the role of the teacher. The computer in post-industrial schools will relieve the teacher of clerical and management chores—it will free the teacher to concentrate on higher-level teaching tasks such as interpreting the significance of information for the individual learner, dealing with the affective aspects of education, spotting and encouraging unique and individual talents. The computer will make a diagnostic/prescriptive model of education quite practical. It will further make large classes look small to the learner and more satisfying for the teacher.

The microcomputer will open up new economic opportunities for teachers. First of all, we will need to write materials that bring the computer into every level of education—kindergarten to graduate school—and into every subject area. If that is not enough, we will probably need to rewrite our curricula in several different ways to meet the needs of people with different learning styles.

Right now, the nation's public schools spend about one billion dollars a year on textbooks and other teaching materials—much of it wasted. Educational Products Information Exchange Institute conducted a two-year study of about 300 fourth and tenth graders and found that the majority either knew most of the content beforehand or gained little after using their texts. This is a situation we *have* to change—and computers can help us.

Schools now spend 3½ percent of their learning materials budgets for computers and accompanying software, says Harvey Brudner, an educational consultant. Brudner predicts 400 percent growth over the next five years, bringing computer-related sales to schools to $300 million, or 14 percent of the total learning materials budget. It may go even higher, and teacher/authors will be among the major beneficiaries.

The World a Classroom

Government and industry will also need teachers as these institutions begin to use the computer as a medium for training and marketing and for communicating complex information. Indeed, the microcomputer will probably extend formal education into every area of society, creating competitive bidding for the professional services of trained educators.

A third opportunity for educators is the chance to help redefine what is intrinsically human work. Prior to the industrial revolution, human beings had to work as beasts of burden. Since the industrial revolution, human beings have had to work like machines in factories, performing dehumanizing work. Many of our schools have come to be organized like factories—turning out alienated human beings like so many sausages. The microcomputer gives us a chance to change this.

Clearly computers are much better than humans at performing dull, repetitive, algorithmic work and much less affected by hazardous work environments. But computers can't replace humans for work that requires curiosity, creativity, humor, love, emotional sensitivity or fresh insight. Educators can help us rediscover this basic truth and reorganize our institutions accordingly.

CDC's PLATO

Cont. from page 1

he mumbles. With one finger he types "3" and "5/3."

"Think 7," the PLATO screen reads. The number line reappears, divided into eight units from zero to seven with the line between three and four divided into fourths. Clever jumps to the seven.

"Take away 3 1/4," flashes the screen.

Clever leaps to the three-quarter mark between the three and the four.

When the next problem appears, David enters a crazy answer. He folds his arms and pushes his chair back. "I don't get this at all," he mutters.

Hearing David's difficulty, Pat White, the supervisor of the learning center, asks David if he understands what the graph is trying to show him. David shakes his head no, and Pat shows him how to borrow one in fractional form from the number on the top. "Ah hah!" David exclaims.

David's correct answers to the next four problems bring more "Supers!" and "Dynamites!" from Clever. The problems in the next lesson, involving subtracting fractions with different denominators, follow. Now that he knows how to do the new kind of problems, he finishes the fraction work in 15 minutes.

"I think I'll play a game," David says. "Is it OK if I play *Drag Strip*?" he asks Pat, and gets ready for the game, his reward for a job well done.

David is studying fractions and polishing his comprehension skills with the computerized Basic Skills curriculum because he was not doing well in school. In fifth grade "I had C's and D's," he observes.

"He was the class clown, and now he isn't. His grades have improved—B's and A's—and he's ahead of his class in math," adds his mother.

David's fifth-grade teacher recommended he go to summer school, but David's parents decided to send him to the Control Data Learning Center instead. Since then, David has worked through about 30 skills "clusters" at seven dollars a cluster.

David is one of several thousand students who have worked with the Basic Skills Learning System (BSLS) since 1978. BSLS is available on PLATO terminals located in schools, prisons and Control Data's own Learning Centers around the country. Each of the terminals is tied via phone lines to a Control Data Cyber computer in Minnesota.

Comprehensive Program

BSLS represents a commercial application of technology first developed in the 1960's at the University of Illinois. BSLS itself was conceived after a Control Data study indicated that the 20 million illiterate adults in the U.S. represented a strong market for a comprehensive computerized skills program to teach reading, math and language skills. Because BSLS is one of the largest, coherent academic skills programs on the market, having taken two years and several million dollars to develop, it provides a good vehicle for examining how comprehensive educational computer programs might work in schools.

BSLS is the 3 R's delivered on a sophisticated computer system. The computer presents lessons and quizzes, as it did with David, and tells students whether their answers are right or wrong. It also determines what skills students should begin with. As they progress from lesson to lesson, it keeps track of their progress. Students can enter their answers by typing on their PLATO terminal, or by using a touch-sensitive screen. The terminal screen resolution of over 500-by-500 pixels makes its graphics capability an important part of many lessons. The images drawn on the PLATO terminal are so clear that in David's *Drag Strip* game, the terminal can show the moving spokes of the quarter-inch diameter race car wheels as the cars are pushed to the starting point.

BSLS teaches three kinds of skills: math, reading and language. After beginning with basic number concepts, math students work through fractions and decimals to special topics like ratio, proportion and geometry. Skills work in word structure, vocabulary and reading comprehension make up the reading section of BSLS. And in the language curriculum, students improve their writing skills by learning mechanics and usage rules and by studying sentence and paragraph structure.

> *Before continuing with a lesson, students can call up a list of hard words, eliminating the vocabulary problems that can interfere with learning reading comprehension skills.*

When students begin work in one of the BSLS curricula, they take a pretest on the computer that indicates the skill with which they should begin. Thereafter, before going on to the next skill in the sequence, students must pass a test on the skill they've been studying. To construct the test, the Control Data computer in Minneapolis chooses items at random from its test item bank. This prevents students from passing tests by memorizing the test items. It also means that students who do not learn a skill from the work they are doing on the computer cannot progress without an instructor's help.

BSLS in Action

What is it like to work on a BSLS lesson? Take one of the last lessons in the reading comprehension section, "Finding the Main Idea," as an example. The lesson begins with a graphic flourish. The computer draws a flower of many squares plotted on top of one another at slightly increasing angles; in the center of the bloom, it prints the subject strand and skill. It then presents the pretest.

The pretest consists of four paragraphs: the first describes a woman at the Smithsonian Institution who opens packages containing everything from bugs to petrified wood; the second suggests that talking is an important form of communication; the third recalls snuggling inside a warm bed on a cold, winter school morning; and the fourth gives advice on making root-beer floats. As students guess what the main idea of each paragraph is, the computer tells them whether they are correct or not. At the end, it compares the scores needed for mastery to the students' scores. With two or more incorrect answers, the computer prints, "You did not pass the pretest."

Students can stop working with the PLATO terminal at the end of the pretest. When they sign on again, the computer will start them at exactly the spot where they left off. If they decide to study the tutorial, the computer draws "Finding the MAIN IDEA" in large block letters over the screen.

"Everything that we read has a main idea." Pressing "next" brings a second rule printed below the first.

"Main idea is an important point the author wants you to remember."

In all, three rules appear, and then a two-paragraph story about some people who used a pesticide to kill mosquitoes and caused an ecological disaster in the process.

Before continuing with the exercise, students can touch the phone in the bottom left corner of the screen and call up a list of "hard" words. In this way, BSLS overcomes the vocabulary problems that can interfere with teaching reading comprehension.

After the students have studied the words they don't know, they must choose the sentence that restates the main idea from three printed below the paragraph:

- "Sometimes man tries to correct one problem and by doing so causes many others,"
- "Natives were eaten out of house and home,"
- "The best way to control insects is always to spray them with insecticide."

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CDC's PLATO

Cont. from page 4

Selecting a wrong answer leads the computer to review the main idea rules, present some new ones and then move back to the pesticide story and the three questions about its main idea. If the students choose a wrong answer here, the paragraph containing the main idea gets underlined. The only answer left is the correct one, which the students must select to continue with the lesson.

The suggestions for finding the main idea are reviewed once more, followed by two exercises. After finishing the exercises, students may "recycle" through the lesson they have just examined or work on two more paragraphs. Upon finishing these, they can stop, take the tutorial again, review or proceed to drill and practice.

Assessing Effectiveness

How effective is BSLS at improving students' skills? To David's parents, the PLATO BSLS is a total success. David is clearly farther ahead in math than he was when he began sixth grade. How much he has progressed in reading is not clear. While he finished the composition strand, he got stuck in the module that teaches picking out the facts that support the main idea. In the weeks before, he had passed the pretests for several previous skills in the sequence. This phenomenon, known as "pretesting out" of a skill lesson, is fairly common among students working with BSLS. The precise effect has not been established. Pat White, the learning center supervisor, suspects that this led to David's failing to pass the last test in the comprehension strand.

Another problem lies with the type of reinforcement PLATO provides. While one of the things teachers like most about the system is the positive reinforcement it gives children for correct answers (Clever's exclamations of "Dynamite!" "Super!"), sometimes it offers those positive comments inappropriately. For example, in the "Find the Main Idea" lesson cited earlier, the computer said "Excellent. That was a difficult paragraph, and you got the main idea easily," after the student had made two incorrect guesses and found the correct answer only by a process of elimination. Also, the responses to wrong answers are sometimes harsh. The first response to a wrong answer on a suffix lesson was "No Way," leaving the adult student feeling a little bruised.

To date, few systematic studies have examined the effectiveness of BSLS, making the anecdotal reports hard to corroborate with research data. People associated with Control Data have conducted some preliminary studies that have shown that BSLS has produced startling improvements with adult illiterates. At the Adult Learning Center in Baltimore, for example, after 15 hours of work with BSLS, students showed nearly a year's gain on a standardized achievement test. BSLS has helped illiterate Navy and Coast Guard recruits read well enough to begin regular training. But other preliminary studies suggest that BSLS is not always effective. At the Bexar Prison in Texas, prisoners, for many of whom English was not a first language, showed no significant gains. Some of the prisoners felt the PLATO system was another device used by the warden to control them.

A reading professor at a leading university claims the BSLS reading curriculum really doesn't teach reading skills: it only gives students practice in using the skills. Clearly, David's math tutorial didn't teach him how to borrow when subtracting fractions. Pat White had to do it. But that's her job. "Students need someone to talk to," she says. "Kids are shy. They often won't raise their hands . . . . You have to be highly motivated to go all the way through with no one to discuss the stuff with."

> *A reading professor at a leading university claims that BSLS doesn't teach reading skills; it only gives students practice in using the skills.*

One School's Experience

One senses that the most appropriate school use for a system such as PLATO BSLS is as a drill-and-practice adjunct to materials teachers are already presenting. At least one school's experience bears this out.

At Berando Junior High School in the Watts section of Los Angeles, Principal Rosalyn Heyman supervises a staff that teaches students from 24 countries who speak 17 languages. In five years she has changed one of the toughest schools in the district to a model junior high that was recently profiled in the *Christian Science Monitor.* She has tailored instruction to individual student's needs, built curriculum, given her new teachers effective teaching tools and made her students proud of their school. As part of this improvement, she spends $80,000 annually, mostly Title I funds, on 12 PLATO terminals and BSLS. When she subscribed to PLATO in 1979, she was looking for a complete system that would diagnose student weaknesses, teach skills and keep track of student progress. She is generally pleased with BSLS.

"It fits right in because it tests kids; it has objectives, it has strands," says Heyman. "If a kid doesn't know something, it helps him learn it. He gets reinforcement, and he gets repetition, and he can ask to see a lesson as many times as he wants. And he's not embarrassed by having to say to the teacher, 'Well, tell me again.' "

In the first year, Berando had eight PLATO terminals. During the school's six-period day, the eight terminals presented BSLS math lessons for two periods, reading for two and English for two. Students came out of their regular classes to work at the terminals in the media center for ten weeks during the year.

Students had to make up the work they missed in their regular classes, and this caused problems. Students never really caught up, and the BSLS work often seemed disconnected from the regular course content.

For the 1980-81 school year, Heyman reorganized the schedule for the computer work. Whole classes are scheduled into the media center for 12-week periods. On Mondays and Tuesdays, half the students study with BSLS while the others work in small groups or individually and have conferences with their teacher. In language arts, for example, students "can do their composition work or their creative writing, work that isn't really done so much on the computer." Working in this way Berando students will spend about 25 hours with BSLS on the computer this year.

The new schedule appears to be effective. Reading and math scores are up, though Heyman cautions this is due to many factors other than PLATO BSLS.

In general, Heyman feels that BSLS has helped improve attendance and attitude. Kids are fighting to get on the terminals. They are excited enough about learning to stay after school. "It doesn't take the place of the teacher, but it's a new dimension . . . . It methodically goes through and finds what they don't know and then teaches them the part they don't know. The part they know, they don't have to repeat on the computer."

As for the $80,000, is it worth it? "You have to make some sacrifices," Heyman says. "Maybe you're going to have fewer assemblies, fewer film strips, fewer aides . . . . Maybe you're going to have one less teacher in the classroom. But you have to make some sacrifice to try something new. But isn't that being on the growing edge, to try something? If it doesn't work you can quit; but if you don't try it, how do you know?"

Jeffrey Nilson, an eighth-grade English teacher, is a contributing editor to Classroom Computer News.

BASIC in the Bunkhouse

Those "How I Spent My Summer Vacation" essays will never be the same, at least not for children attending the fourth annual National Computer Camp in Moodus, Connecticut.

This July, 10- to 17-year-old computer enthusiasts will gather for a week of structured activities with "counselors" more proficient in BASIC than in the crawl. As does any good camp program, this one keeps its campers going morning, noon and night. For the morning sessions, which run from 9:00 AM to noon, campers divide into sections of 12 to 15 children each, with an instructor, an assistant, and four or five Radio Shack and Wang computers. The campers, who are grouped according to computer experience and age, work three to a machine on programming problems their instructors devise or which they create for themselves during morning free time.

According to Michael Zabinski, camp founder and director, members of the Machine Language section, the camp's most advanced group, are usually the most diverse in age. They range from precocious 11 year olds to high school juniors and seniors ready to out-program their soon-to-be MIT professors.

During the afternoon, campers are encouraged, but not required, to participate in outdoor, non-computer activities such as swimming and basketball. But "at least half" choose not to, says Zabinski, preferring the mental exercise their computers allow.

Evenings bring sports tournaments and Las Vegas night, but lest these sound like ordinary camp fare, rest assured that the playing field and the game room are always on the video screen. And, stresses Zabinski, "all the games are interwoven with serious programming."

Steve Lynch

The week-long National Computer Camp also incorporates discussions of such issues as the social implications of computers, and, to wrest attention from the small screens for awhile, it offers big screen showings of popular films. It is located on a site used for more traditional camps during the rest of the summer; about a quarter of the campers are girls. Director Zabinski, who is a professor at Fairfield University, Connecticut, says he founded the camp because he's worked with teachers interested in computers "for years" and wanted a way to reach the kids.

The 1981 National Computer Camp will hold two sessions this summer: first session July 19-24; second session July 26-31. For further information, contact Michael Zabinski, Ph.D., at 205/795-9069, or write to Computer Camp, Grand View Lodge, Box 22, Moodus, CT 06469.

Project to Evaluate Math Programs

A project to develop and disseminate exemplary curricular materials that use computers to teach upper elementary-level math skills and computer literacy is now underway at Ohio State University's College of Education. Funded by the U.S. Department of Education, the project will collect and evaluate existing educational software for microcomputers, as well as develop new curricular materials.

According to Project Director Suzanne Damarin, the Ohio State group is developing programs to teach such subjects as estimation, geometry and problem solving, subjects to which, she says, "everyone pays lip service," but for which few good computer-based lessons exist. The curricula will be field tested and disseminated nationally, probably on floppy disk with accompanying written information.

The group is interested in reviewing existing programs in *all* basic math skill areas, however, for possible inclusion in its final report. The report will incorporate a list of recommended programs to supplement the new curricular materials.

Damarin and her colleagues invite individuals and groups who have developed programs related to mathematics at the upper elementary school level to submit their programs. Such criteria as mathematical viability, ease with which children can use the program and appropriateness of reinforcements will guide the evaluations.

To have materials considered, send a cassette tape or floppy disk, together with a printout, machine documentation and any other related information, to Dr. Suzanne K. Damarin, TABS Project, Arps Hall 202-A, 1945 N. High St., Columbus, Ohio 43210. For further information write to Damarin at the above address or call 614/422-1257.

Foundation Awards $150,000 Worth of Microcomputer Equipment

The Foundation for the Advancement of Computer-Aided Education has awarded nearly $150,000 worth of microcomputer-based systems to 26 educational groups.

This is the fourth set of awards the foundation has made since October 1979; it raises to approximately $500,000 the value of grants given to educational institutions and individuals.

Originally chartered as the Apple Education Foundation, in 1979, the Foundation for the Advancement of Computer-Aided Education is a nonprofit corporation established to support and develop new methods of learning through the innovative use of small computers. Most of the systems provided under the grants include Apple II personal computers, manufactured by Apple Computer, Inc., of Cupertino, Calif., the principal sponsor of the foundation.

The awards were given for projects at the elementary, junior high, high school, college and university levels, and for foreign language and special education projects.

"The foundation awards have greatly stimulated the use of microcomputers in

Please turn to page 18

George Bellerose/Stock Boston

With computer-prepared Individualized Educational Plans available, special needs teachers spend less time on administration and more time working with students, such as this child who has cerebral palsy.

Managing the Administrative Morass of Special Needs

by Kirk Wilson

A new approach to the education of handicapped children is encouraging great enthusiasm as well as causing considerable frustration among parents and special educators. On the side of enthusiasm, Phyllis Proia, parent of a 15-year-old learning disabled child, says, "It is like a miracle to know exactly what the school system is doing for our boy after so many years when we could not even find an appropriate program for him." On the other hand, as one teacher put it, "I just told the administration I couldn't do my job anymore and quit."

The controversy stems from new legal requirements in special education for individualized education and mainstreaming (the integration of handicapped children into regular classrooms). While the principles underlying this new look for special education have garnered almost universal support, individualized education has also stimulated strong demands from parents, teachers and administrators for increased services, more special training and easy-to-use classroom management tools. In the face of dramatically increasing paperwork, one of the most pressing needs is for a support system to decrease the paper shuffling that increasingly hampers the teacher's ability to plan effectively and to monitor the handicapped child's education.

Consider what microcomputers are doing to individualize special education. The day might not be too far off when similar individualization demands are made on regular education.

The good news in 1975 was that Congress had passed the Education for All Handicapped Children Act. This landmark legislation guaranteed every handicapped child the right to a free and appropriate education. The bad news was that special and regular educators had simply not been given the necessary resources to meet the challenges of this new law.

While Public Law 94-142 required that handicapped children be serviced individually and "integrated" into regular education wherever possible, it did not, unfortunately, indicate how. Despite Congress's allocation of over one billion dollars in 1981, most special educators still do not feel that they have been adequately trained to individualize education as the law requires, and administrators are constantly reminded of the lack of management tools necessary to do the considerably more demanding and exacting jobs now expected of them.

Special education teachers must now prepare annual Individualized Educational Plans (IEP) of two to 25 pages for each of this country's 4.03 million handicapped students. The IEP must state present levels of performance, specific, individualized annual goals and short-term objectives for the coming year.

Once the parents have accepted the IEP, the special education administrator is also guided by this semi-legal contract for educational services. Special education administrators are being overwhelmed by the demand for new services for handicapped students and, as usual, underwhelmed by the financial resources available to provide the necessary programs. The enormous fiscal constraints mean that many valuable programs unfortunately cannot be implemented.

The situation in special education has become a classic management problem: a large amount of planning information must be created, decisions must be implemented and the results must be monitored. As the reader might expect, microcomputers are gaining rapid acceptance not only for student instruction but also as efficient and cost-effective planning tools for teachers and administrators.

Microcomputers to the Rescue

The ideal IEP, as specified by the law, contains a variety of information developed by parents and special educators who plan as a team. An effective IEP helps to plan daily special education, to assist regular teachers working with handicapped children and, in general, to manage programs for handicapped children who may be served by a variety of educators and specialists.

The IEP requires a current assessment of a student's ability and performance. Beyond these very individual statements, however, it also requires information of a more general nature that can be stored in a microcomputer data base. General goals, extremely specific short-term objectives, methodology statements, costs of services and other resources for program planning can all be stored on disks. IEP planners can use this data base as a guide or can literally select goals and objectives from it and insert them into a particular student's IEP.

Within the IEP, the microcomputer may also provide a data base of instruction methods recommended to achieve a particular goal (often appreciated by "regular" teachers working with mainstreamed children) and may even specify materials that have been successful and where to find them within a particular school system.

By transforming IEP preparation from a creative writing exercise into a decision making process, the microcomputer will not only increase the special educator's efficiency, but may also allow the parent to become a true partner in the planning process as P.L. 94-142 requires. The intent of P.L. 94-142 was that parents and educators would jointly plan for the child, but at present IEPs take so long to write that the special education staff prepares a complete IEP in advance, and then the parent accepts or rejects it. The microcomputer can change all this.

Special Education Software

Over the past few years, a number of special purpose software systems have been developed to support the individualization of special education. To date, the main approach has been to use a large central computer system as a "service bureau." Computer-assisted IEP development, maintenance of various curriculum data bases, specialized testing and monitoring of student progress are among the main functions of the service bureaus.

Service bureaus can be either commercial, such as Gacka Computer-Aided IEPs, from Curriculum Associates, Inc., North Billerica, Mass., or publicly supported, of which The Child-Based Information System of the Central Susquehanna Intermediate Unit, Lewisburg, Pa., is a good example. (The Child-Based Information System primarily services a number of area school districts.) The majority of them require a "batch mode" operation. Teachers and administrators send a batch of coded forms to the bureau and receive in return computer-generated IEPs as well as administrative reports of various kinds. Turn-around time can be upward of a week.

The Control Data Corporation is taking a different approach. It is developing a prototype IEP system that monitors a student from initial screening for the handicap through assessment, program selection, IEP development and educational achievement. The Control Data IEP system will be accessed through PLATO terminals. (PLATO is a time-sharing educational system which CDC developed during the 1970s.) The corporation plans to field test its system within a year.

Software developers for microcomputers are also producing systems to speed IEP generation. Microcomputer systems such as Programming for Individualized Education, available from Educational Turnkey Systems, Falls Church, Va., and MicroPlanner, now being tested by Learning Tools Inc., Brookline, Mass., offer the teacher and the administrator direct access to computer resources with less delay than the traditional batch mode approach.

Microcomputer systems follow the same operational procedures as larger systems. After evaluating assessment data on a student, relevant goals and short-term objectives are displayed on the microcomputer television display or monitor. The IEP planning team must then select from the goal and objective data base those items that seem appropriate for inclusion in the student's IEP. If a teacher or parent desires to create a new goal or objective, he or she can easily insert it into the IEP. By creating new goals and objectives, parents and teachers communicate that gaps exist in the curriculum. These new goals and objectives are automatically saved for review and for possible inclusion in the main data base.

IEPs that once took three to ten hours to develop take 30 to 60 minutes using computer-assisted systems. While everyone appreciates a time savings, the major benefit is that teachers are now able to function more as decision makers than as curriculum developers creating new goals and objectives for each and every student IEP.

For Administrators, Too

While some may argue that teachers are most in need of planning and management tools, special education administrators are quite convinced that theirs is the most demanding task.

With the demand for increasing individualized services (e.g., hydrotherapy for cerebral palsied children, new computer-based reading machines for the blind, sign language programs for Spanish-speaking handicapped children), administrators must diplomatically allocate funds and carefully justify budgets. Administrative software reports now not only describe numbers of children and their special program needs, but also list current costs and available staff and material resources. With the comprehensive lists of services and cost analyses computer systems allow, administrators can improve their arguments for funding and clarify more specifically exactly what services their schools provide for handicapped children.

Whether teachers and administrators access computer resources in a batch mode, via terminals connected to remote computers or by typing on a microcomputer at their own desks, special education management information systems are finding a welcome home in special education programs throughout the country.

A list of special education support systems is available free from: Learning Tools Inc., 4 Washburn Place, Brookline, MA 02146

Dr. Kirk Wilson is a research associate at the Boston University School of Education and a co-director of ILIAD, a computer-based program for deaf children.

Journey through Mathland: An Interview with Seymour Papert

The creator of LOGO discusses computers and children and how they should talk together

by Peter Kelman

"Mathland is to mathematics what France is to French," said Seymour Papert at a recent conference. "If you grew up with everyone around you speaking mathematics, you would learn math in a perfectly natural way."

Papert, who is professor of mathematics and Cecil and Ida Green professor of education at the Massachusetts Institute of Technology, believes that the computer is the portal into "Mathland" and that the computer language he has developed, LOGO, is the key. LOGO transforms the computer into a tool through which children can explore a world ruled and manipulated by math. It places children in control of their own forays into this Mathland, and in so doing, suggests Papert, it can radically alter the way children learn and, by extension, the way teachers teach.

In an interview with Peter Kelman, assistant professor of education at Dartmouth College, Papert discusses his approach to computers in education. (For a review of Papert's recently published book, Mindstorms: Children, Computers, and Powerful Ideas, *please see page 25.)*

P.K. In your book, Mindstorms, *you speak about using computers in a manner that is quite different from current educational uses. You call this using computers as "objects to think with." What do you mean by that?*

S.P. Partly, I'm referring to using the computer as a metaphor because I think in order to engage with a problem you need always to refer it to something that is familiar. The example I discuss in *Mindstorms* is a cybernetic animal we've invented called a Turtle which is often a very powerful metaphor for lots of mathematical situations. A curve, for example, is something that is hard for a non-mathematician to come to grips with, but if you imagine a Turtle walking along it, going forward, turning and so forth, it enables you to put yourself in the curve. You are really using this object as a metaphor to make a relationship between you and the curve. I think a lot of thinking is much more concrete, in that sense, than is generally recognized, certainly by philosophers and logicians and even by psychologists.

Would you describe at least one of the forms the Turtle may take for those who haven't read Mindstorms *and aren't familiar with the LOGO project?*

It's a cybernetic animal. It actually exists. It looks a little bit like a turtle. It's round, it has a shell on its back, and it can move around on the floor. It moves under computer control. Usually it has a pen and can draw with it on a big piece of paper. Children are able to control it by typing instructions on a keyboard and so get into the situation of working with this object using mathematical concepts, mathematical in a very general sense, in order to cause action in the world.

> *"Programming is well rooted in the life of the child—we're carrying out procedures all the time."*

What sort of commands can a child give to a Turtle?

The simplest is to move forward, that is the way it's facing. It's got a face and can move forward some distance. We sometimes start children by not forcing them to use numbers. They can give a command FORWARD and move some standard amount. And then later they can have the option of using numbers if they want to get a finer control over it. There *are* some mathophobic kids who don't want to have anything to do with numbers. But after awhile they invariably start wanting the number because you can simply do more with this, with less effort. The other fundamental command is having it change its direction by doing a right turn or a left turn, commands children can identify with. Here you have to tell it in degrees how much it has to turn.

Would a child have to know what a 90-degree angle was or a 45-degree angle in order to give the Turtle a command?

Usually they don't. Usually, we say "choose any number."

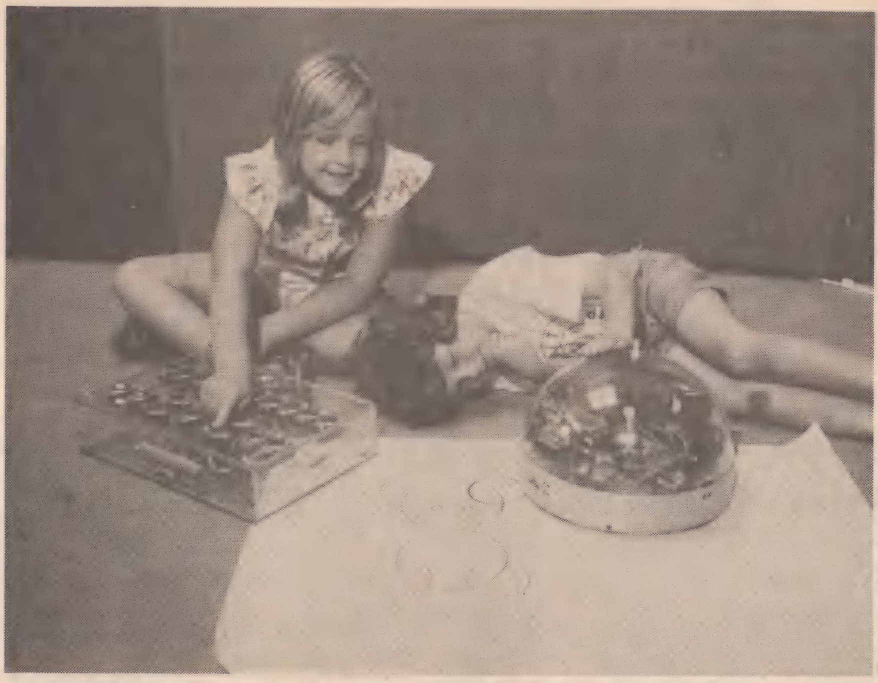
Three thousand?

Some of them choose numbers like 3000. They give all sorts of funny numbers. They have no idea what the numbers mean, but bit by bit they discover. And this is really remarkable. There's no question, that given enough time . . . it might take them a long time . . . they discover the needed angles.

Something I've been gradually coming to understand more forcibly is that when you say "children learn well in a new situation," the education world tends to interpret that as "fast," and that has something to do with the ways schools are set up, this very scarce resource of teacher time that has to be parceled out. I don't know whether these kids learn "fast," but they seem very willing to spend a lot of time at it, so that they learn *well.*

So you begin with the kids "messing about," as David Hawkins would say?

Yes, you get a chance to "mess about" with other uses of number than counting. There are *some* aspects of number that are well-rooted in our society and for which we have very good objects to think with. The fingers are an object to think about numbers with. The use of the fingers is not merely a substitute for looking up in a table or a calculator. It gives you a very concrete, personal way to think about numbers. I think those aspects of number that the fingers are good for thinking about develop very well in our children, independent of schooling. But, for example, there isn't a way to mess about with the use of numbers to represent quantities proportionally, and children have very bad ideas about this. It's incredible . . . a child has seen that the instruction FORWARD will make a Turtle move, and I say, "Move it up to my finger." The child guesses some number, 20, and the Turtle moves halfway to my finger. I ask "What'll you do to get it there?" A six-



Courtesy of Basic Books

The LOGO Turtle, a cybernetic "object to think with."

or seven-year-old is very likely to try 21 or 200, showing no sense of even approximately the proportion.

Then you believe that an object to think with must involve the children in using their bodies to think?

I'm not trying to say that all knowledge is rooted in body knowledge, but I do think very important knowledge has that form, especially mathematics. It's paradoxical maybe, in terms of our society's way of classifying mathematics as very abstract and very non-bodily, that in fact, certainly for the child in the beginning it's a very bodily kind of knowledge. Objects to think about *mathematics* with are typically of that sort of body-connected form.

In Mindstorms *you say "that all children will, under the right conditions, acquire proficiency with programming that will make it one of their more advanced intellectual accomplishments." This sounds very much like the Woods Hole group—Bruner, Zacharias, et al.—saying, "The child can learn anything at any time . . ."*

Not at all. I think programming is special because of these two sides we see in the Turtle: it's well rooted in the life of the child because everybody does lots of programmed things; we're carrying out procedures all the time. It's also something that has many points of contact with almost everything we might like to think about, so when we appropriate it, we can use it. We can appropriate it neatly.

Yes, that's a very powerful argument for the Turtle, but not for the Turtle exclusively, and not even for computerized cybernetic creatures in general. There are many other such objects to think with that are rooted in our experience and that have knowledge embedded in them: for example, tape recorders, cameras, typewriters, sewing machines, looms, woodworking tools, etc.

Yes, I felt a tremendous sense of liberation when I thought of starting the book with the gears of my childhood. There isn't anything unique about the computer. What the computer does for these kids, gears did for me. What's special about the computer is its protean quality. You can do more of this kind of thing. It has more manifestations. It can be used for an infinitely greater diversity of such purposes. You can mold it to a form that fits more closely your needs, but what it does is of a kind with all the examples you mentioned or rather of a kind with what *can* be done with those examples.

Ah! But if schools and teachers in schools have not generally used all the various other "objects to think with" that are right in front of their noses in the past, what makes you think that they will use this "scary" cybernetic animal, which costs money besides?

Well, I don't think I ever said that they would. I think there's a challenge, an opportunity. I think there's a very good possibility it won't be taken up and that particularly it won't be taken up by schools.

I think it would be stupidly complacent to think the computer has come and it's going to solve our problems of education. If we look around we see that the computer has come and it's being appropriated by "the system." Nevertheless, I think there are some special features of the computer that are promising. The one that strikes me as most important is that once you cross a threshold of making a computer system that can be mastered by a child, the possibility of the child taking over is so much greater than in any other example I can think of.

My favorite stories of what's happened with recent experiments in which we've been able to put many more computers in a school setting all have to do with the child taking over. I think it's very dramatic. For example, the Lamplighter School is probably unique: there are 50 computers in a school that goes up to fourth grade from four-year-olds. Most of the computers are in first through fourth grade, where there are 200 kids—a very high concentration of computer power, high enough, I think, to get up to a point where something like a "computer culture" becomes not metaphorical but very real. We see over and over again how the kids blow the teachers' plans for the way the computer should be used.

My favorite example: the teachers decided that, in first grade, they should very carefully meter out the concepts to the children—one a week. They certainly shouldn't teach programming until halfway through the year, so they had the kids giving direct commands to the screen objects and they were moving them around, changing their color, changing their shape. Kids liked it. It's a lot of fun. There's a lot of things you can do like that, but there are much more exciting things you can do when you start putting them in motion, but teachers decided that's much harder or to keep it for later. This worked up to a very precise point, determined by factors of a perfectly objective nature: when the kids knew enough to be able to see what was happening in the fourth grade and to ask an intelligent question of the fourth graders, the teachers' plan collapsed. As soon as this happened, a kid found out from a fourth grader how to do something that was "outside," and then not only brought it back as an exciting thing to do, but it had this extra element of feeling "subversive." I saw the child two days later, and he explained how he had now taught 14 first-grade kids how to do this "illegal" thing.

There aren't many materials that allow that process, and I think it's because the computer really does so concretize the abstract that it allows the kid to break out of the grip of the teacher. I think that's fantastic. I'm not so critical of teachers. I think teachers want to teach well. I think this is a very good thing for the teachers. When they see the kids break loose in this way, very few of them get too upset. On the whole, they see

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Computing on the Big Screen: A Class Act

Hooked up to a TV, one micro can serve an entire class

by Gloria Stein

William L. Morgan

A computer game of TICTACPET becomes a class activity with the addition of a large TV.

If you are a teacher and fate has placed you in the fortunate position of having a microcomputer and a TV set at your disposal, marry them. You'll love the reception!

Computer stores sell an easy to use, inexpensive device called an r/f modulator that connects the micro to the TV, performing the necessary ceremony. From this day forward, anything appearing on the micro screen will also appear on the TV in full view of your entire class, exposing students to the awesome, motivating influence of the computer, which their own interaction will further heighten.

Why force this electronic, connubial bliss? Lots of reasons, all of them good.

From Abuse to Use

Take the case of simulation games. Simulations attuned to the Westward Movement, such as *Oregon Trail,* purport to take the user through the tribulations of your average Conestoga train.

Adults, previewing the program, say, "Good. A little of everything: social studies, math computation, estimation, problem solving, etc." The children love these games, but they don't give a hoot if they reach the Pacific or not; they want to play with the animated graphics. You have to admit, a "buffalo hunt" or a "race with the chief" *is* fun, but the program is abused.

What to do? Outlaw the program? Not yet. Haul out your newly married couple, place a student at the micro as Wagonmaster/mistress, let the others gather around, and then exert a subtle influence.

At the beginning of the program, you must outfit your wagon train: food, clothes, supplies and ammunition. This accomplished, the program may ask, "Do you want to hunt?" The children respond heartily, "Yeah!" You inquire, "Why? You haven't left town yet."

Responses vary, but ultimately, an honest soul will admit, "Just for fun."

Resist. Say no more; you've already planted a seed. However, persist whenever your students make a "fun" decision as opposed to an intelligent judgment. Ask why.

By the third time I perpetrated this experiment against one class, the children were converted. They desperately wanted to reach their goal, had incorporated both political and topographical maps into the activity, and were truly learning through the practice of the skills the program demanded.

Did it spoil their fun? Quite the contrary. They volunteered the information that playing the game "straight" was much more satisfying.

Serendipity Supreme

If you use micro/TV presentation often enough and hold good thoughts in your heart (neat trick!), chance will serve you well. Another classroom vignette.

Goal: teach the concept of ordered number pairs; the proper use of an *x/y* grid. Program: checkers. Reaction of children: involved because of the computer, but not scintillating. Checkers is, after all, a bit old hat.

Things were perking along well, when the youngster manipulating the computer entered an ordered number pair incorrectly. Consequently, his "man" popped into reverse.

"Aha!" cried the intelligent pedagogue. "See what happens when you don't pay attention to the order?"

"Aha!" cried the children, not paying any attention to the intelligent pedagogue. "Does that mean you can move your man *anywhere*?"

(Warning: when serendipity rears its lovely head, grab it.)

"Don't know," muttered the deflated pedagogue. "Try it."

They did and they could. The reaction was electric. The students surged closer to the TV, edging out the now extraneous pedagogue.

Then, they read an *x/y* grid and used ordered number pairs with an excitation no amount of teacher planning could have engendered. They not only made legal moves, but also snuck up from behind the opponent and attacked from the rear. The poor computer didn't know what hit it. It was great!

The Old Reverse Psychology Caper

Some programs that offer ascending levels of difficulty challenge advanced students but are potentially intimidating for others. This does not preclude your use of such a program with an entire class.

TICTACPET, written by Jo Ann Comito, is a superb pre-algebra program using the basic tic-tac-toe format. Solution of the equation located in a given box earns an X or an O. If an incorrect solution is entered, the opponent has a chance at the same box. Thus, the program heightens competition and demands mathematical accuracy.

After a recent, orthodox classroom presentation of the concepts involved, I offered this program via TV. To take the heat off the children actually working on the computer, I divided the rest of the class into two teams. The solution to a given equation became a team responsibility. The beginning level, only, was permitted. Before long, everyone caught on.

During a second session, the students, by popular demand, tackled the next level of difficulty. No teams needed. The children not working directly with the computer were solving the equations using the ancient pencil on paper technique. When the beautiful X or O appeared, verifying correct computation, great cheers exploded from the crowd. (Did you ever get that reaction using a ditto?)

Where does the reverse psychology come in? The children were not allowed to even look at other levels of difficulty. As a result, most were chompin' at the bit to get the program under their control.

Soon after, I offered a "free choice" time. Students were allowed to opt in or out. The unanimous choice was TICTACPET; only a few students chose not to participate, indicating that most were willing to extend themselves beyond their usual performance level. They successfully explored all levels, assisting each other through animated discussions about how the equations should be solved. During this time, the teacher was completely free to give individual instruction or, more often, to confirm that a student was "doing this right."

Having discovered a new way of playing computer checkers, the students surged closer to the TV set, edging out the now extraneous teacher.

Try it. You'll enjoy watching students who usually moan, "I don't get it," diligently attacking challenging math.

Epicurean Delights

With the micro/TV set up, you can change your students' usual menu.

The school that houses a sufficient number of computers to fully meet the needs/demands of its population must be rare—if not nonexistent. Most schools can only allot children slots of computer time, possibly as little as 10-15 minutes. Students are often reluctant to "waste" their time investigating unknown programs. They return, time after time, to an old favorite.

When you present new programs to the entire class using regular teaching time, their menu and, therefore, their use of skills are automatically expanded.

Recently, after several TV sessions, groups of two to four children were using the computers. Two young gentlemen registered a complaint, claiming unfair practice because they had requested the use of a computer the previous day and were unable to get one. Since the two were notorious for preferring games with little academic value, the teacher (who shall remain nameless) demanded, rather haughtily, "And just what program did you wish to use?"

"TICTACPET," came the unexpected reply. Chagrined, the nameless teacher ruled in their favor.

Desecrate the Data

BASIC programs are easy to modify. Feel free.

Spelling is a natural subject for this kind of program. Several spelling programs are available that flash a word on the screen momentarily, whereupon the student must type in the same word correctly.

You can give a spelling test using the micro/TV hook up, adding the dimension of visual impact, which orthographic experts tend to encourage. What next? In less than five minutes, you can transform the spelling program into a "speed reading" program merely by substituting phrases or short sentences for the spelling words in the data statements.

When I tried "speed reading" in the classroom, I didn't warn the children about the changes I had made. But they immediately recognized the intent of the new program and excitedly called out the phrases. After the third phrase, they requested that the time the words appeared on the screen be shortened. This was done several times before the end of the program. As it became more challenging, the children became more delighted. This kind of thing can't hurt!

Above and Below

While the experiences described involved a sixth grade class, the micro/TV potential is appropriate at all levels. The applications in secondary schools range from curve plotting in algebra to designing patterns in home ec. It works equally well with kindergarten and first grade classes.

Charming! A group of first graders was introduced to the microcomputer, using the TV. The children spontaneously read aloud anything that appeared on the screen. In response to a computer question, however, they leaned forward and raised their voices, giving the impression that they feared the computer might be a tad hard of hearing.

The TV approach may well be the best application of a microcomputer in the primary grades. Introduction to the computer, facility of use, increased comfort with a new tool, as well as familiarity with the content of the program used, are effected simultaneously.

If you do officiate at this suggested marriage of these two electronic tools for learning, the honeymoon should last a long, long time.

Gloria Stein, a sixth-grade teacher in Ann Arbor, Michigan, has written a booklet called Irreverent: Reference Resource for the Recent Receiver of a new PET!

Putting Computers to the Test in British Columbia

In schools from Victoria to rural towns accessible only by air, microcomputers are setting new directions for BC educators

by Tom Lee

The introduction of microcomputers in the schools is confusing at best. In most places it is being done in an unplanned, unorganized and generally haphazard manner. I like to think of it as the "buy two microcomputers, get one free" syndrome. Teachers who fear microcomputers and the change they might bring are frustrated, as are those who want to get involved but don't have enough information or training to do so. Vendors visiting teachers and schools say that you can't do better than a TRS-80, you can't do better than an Apple, you can't do better than a PET, leaving everyone throwing up his hands.

Teachers in British Columbia (BC) were once part of this confusion. But now BC educators, like those in Minnesota and Texas, to name two other examples, are receiving microcomputers through a wide-based, comprehensive plan. It's refreshing.

The introduction of microcomputers into the schools and curriculum in BC centers around JEM Research, a nonprofit research institute located on the University of Victoria campus. JEM stands for Joint Educational Management, reflecting the group's early focus on projects related to educational administration. Now, through funding and support from the Ministry of Education, they have turned their research expertise to microcomputer technology.

In September 1980, JEM started the pilot stage of a long-range project aimed at introducing microcomputer instruction to all 504,000 public school students in BC. In Canada, the curriculum is heavily controlled at the ministry level, and teachers and schools must adhere to legal requirements for altering curriculum. "You can't simply put materials in the schools, however good they may seem to the teacher," says Annette Wright, research director for the JEM computer project. "You have to have a rationale that is partially educationally based and partially legally based."

What was happening in BC was that microcomputers were going into the schools despite curriculum control. "There were teachers all over the place who had their own machines, who had invested their own money, or a school board's money," says Wright. "We had PETs, we had TRS-80's, we had Apples—you name it—springing up all over the place. People were getting, buying, pirating programs wherever they could and using them. There was no control over what curriculum was being used."

A Systematic Approach

For the one-year pilot stage, which will be completed in September 1981, 100 microcomputers have been placed in 50 schools in 12 districts in BC. According to the project's overall plan, the science curriculum will be implemented on microcomputers in grades 8-10 in September 1981; K-7 language arts, 8-12 music and K-12 mathematics will follow.

Despite curriculum control, microcomputers were going into the schools. People were getting, buying, pirating programs wherever they could and using them.

The schools in the pilot range from large to small, from elementary to secondary and from urban to rural, some so rural that they are only accessible by air. "We wanted a good spread of how the machine was going to be used," says Wright. Some schools put one microcomputer in a classroom for a particular purpose, others put five in a library media center and others have clustered them for the teaching of one particular subject.

"We tried to get away from computer programming in the secondary schools," explains Denyse Forman, who is responsible for software and curriculum development for the pilot project. "We know computers are good for that . . . . We're looking for more creative uses."

JEM plans to monitor the pilots very carefully to see what teachers make of this opportunity. They've asked teachers to be creative, to explore the use of the microcomputer and to report back. "We didn't want to put a research project out there," says Wright. "Teachers don't want to be burdened with university-type research. They haven't got the time, they haven't got the inclination, and we haven't got the time to wait because microprocessor technology is here."

The researchers feel that teachers can be very creative if given the opportunity. "I think that they are showing that right now in BC," says Wright. "They're coming up with ideas. They're very keen to learn to program. And they're not using the microcomputer as a visual aid."

Fears Overcome

One of the common fears that the JEM researchers found while developing the support structure for the pilot project was a feeling that the microcomputer was just another visual aid.

"You cannot describe the interactive nature of a microcomputer to anyone who has not used it in a school situation," says Wright. "They see the screen, the keyboard, and the reaction tends to be: well, in six months it will be gathering dust on the shelves just like that film projector you spent so much money on." JEM overcame this barrier through a strong support structure, aided by the powerful interactive nature of the microcomputer itself.

Acknowledged "computer experts," people who had been involved with larger computers, presented another problem. These people had started using mainframe computers in the 60's, and had become known in their areas. "We found it difficult for them to unlearn the kinds of problems—breakdowns, downtime, phone lines not performing properly—that they had had on mainframe computers," says Wright. "I'm not saying that you don't have problems with microcomputers, but it's a whole different set of problems." Project staff consequently relied heavily on microcomputer hobbyists in developing their support structure.

Choosing the Computer

JEM researchers conducted extensive research, including a field test, to determine what microcomputer to purchase for the pilot study. They finally selected the Apple II, primarily because it offers color, graphic and sound capabilities, and because of existing high quality educational software developed for the Apple by the Minnesota Educational Computer Consortium (MECC). Other reasons included: high resolution graphics, availability of higher level languages including Pascal, BASIC and LISP, easy adaptability to a terminal for time-sharing operation and high impact-resistant modular construction.

"We are more and more convinced that we made the right choice," says Wright. "If we had waited to see what was coming out next week, we would never have started." JEM evaluates other hardware as it becomes available. They've worked with the PET, the Atari, the TRS-80, the Bell & Howell and other microcomputers. JEM's monthly publication, *Micro-Scope*, reports findings.

Shirley Miller / Courtesy of JEM Research

JEM Research is supporting computers in the BC schools on every level, from repair to software.

The portability of the Apple was another important factor in its selection. During the equipment field testing, JEM researchers visited numerous schools, many in isolated rural areas. "Can you imagine carrying around a PET?" asks Forman. "It's big and heavy and all in one piece; its size is intimidating." The Apple, on the other hand, weighs about 12 pounds. In addition, she adds, because it hooks up to a conventional TV, teachers and students can take it home.

As important as the hardware, of course, is the software. "The only justification for having a microcomputer in a classroom," Forman emphasizes, "is the courseware. That's the only justification! If the courseware is not there or if it's not good, you should not have a microcomputer in a classroom."

JEM researchers have been acquiring and evaluating educational software currently available for the Apple II. "We were faced with the overwhelming problem of purchasing all the necessary courseware, evaluating it and suggesting ways it might be integrated into the lesson plans in classroom settings," says Forman.

To keep track of their efforts, JEM researchers have developed a large wall chart in their office on which they enter information about existing programs: grade level and subject; whether the program is tutorial, drill and practice, simulation, demonstration, problem-solving or whatever. In about six months, JEM researchers have located over 700 programs for the Apple II. "We're getting a map of what is available on the market," says Forman. "We're looking for gaps."

There are lots of gaps. The only area that has been completely exhausted is elementary mathematics drill and practice.

"People write us and say, I've got this great program in grade three drill and practice on multiplication," says Forman. "We write back and say, look, that has already been done, and done really well. How about looking at this other area."

A fair number of programs cover secondary mathematics, as well, but not nearly as many as in elementary math.

Forman feels that only one company, Hartley Software, has done a thorough job with elementary school language arts; JEM has found next to nothing in secondary language arts. The picture is a bit better in the sciences. A fair number of eleventh- and twelfth-grade physics, chemistry and biology programs are available and some college-level material can be brought down into the schools for enrichment. However, junior high and elementary school science offerings are bleak. MECC produces some elementary science programs and also comes through with secondary social studies programs.

Filling the Software Gaps

JEM's search for appropriate software underscores one of the problems of the microcomputer industry, a classic audiovisual problem: companies will sell you the hardware and stop there. JEM researchers are approaching this software problem in four ways. They are using commercially available programs; they are looking for good commercial programs that they can adapt; they are helping teachers start developing their own software (JEM gives grants to teachers for software development); they are developing some themselves.

The results of JEM's efforts to provide a support structure for the pilot are compiled in a *Reference Manual* which is

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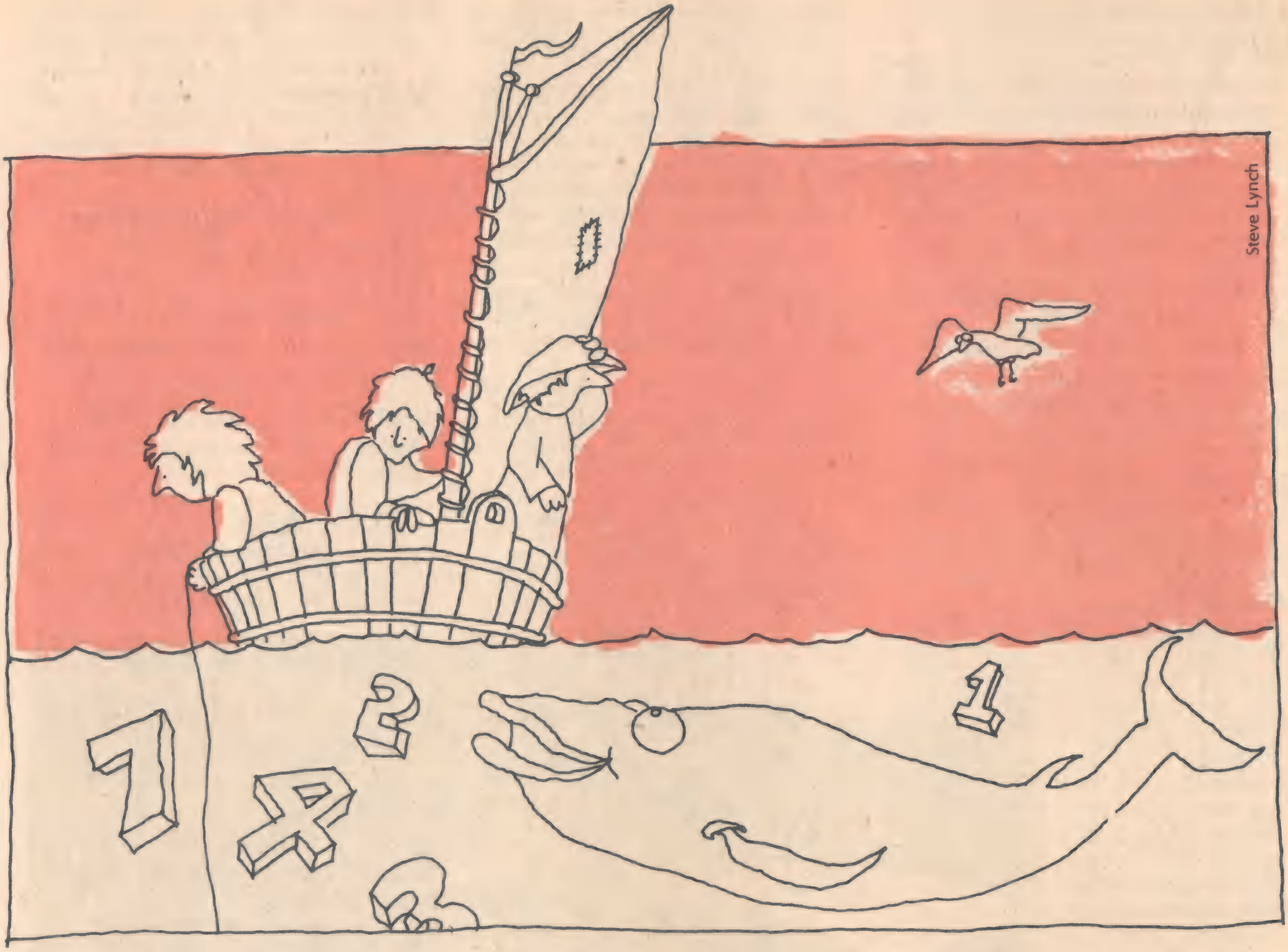

Steve Lynch

To Catch a Mathematical Fish

by Ricky Carter

Catch the Fish is a simple number game that taught me the power of using computers with children as young as five. The game begins by displaying an "ocean" (a dotted number line across the screen) with a "boat" on it (<B>). The player is told that a fish is hiding in the ocean and that he must try to catch the fish by positioning his boat right over it and dropping his hook. The player can choose the size of the ocean, thus determining the complexity of the game. Ocean size can range from one-to-ten to one-to-one-thousand spaces wide.

Once the player has chosen the ocean size, he makes his first guess about the fish's location. The computer positions the boat over the number chosen and drops the "hook." If the fish is not at the number, the computer tells the player that the fish is X number of steps away from the present position, but does not tell in which direction. The child then tries another guess. When he finally locates his boat correctly, the fish appears at the end of the hook.

An Arena for Exploration

From an adult's point of view the game may seem to involve trivial addition or subtraction problems, but I discovered that children from kindergarten through third grade found in it an exciting arena for exploring numbers.

I used this game when I first tried letting five year olds use the school's computer. I was amazed at how quickly these children, who could not yet read, mastered the mechanics of both the computer and the game. They figured out how to use the numbers at the top of the keyboard and the return key almost instantly, and very quickly isolated the part of the screen that flashed the computer's numerical response: X number of steps away. Once they had gotten this far, the problem for the five year olds was to figure out what something like "four steps away" meant.

As the children played, I saw some interesting developments. For most of them, the "four" meant simply to guess that number next. Some children tried this several times, getting different numbers of steps away each time. The failure of this approach often led to counting strategies. But the question was where to start.

Some children counted from zero. Surprise — they often came up with their number. Others counted from the boat, but counted the boat as one. Surprise — they often came up one away. Over several games, most of the children explored different strategies and many of them began to get a sense of which numbers meant you were close and which meant you were further away. Several children played and worked until they figured out an effective counting strategy. The confusion and defeat I had feared just did not materialize.

Approximation and Estimation

Each age level had its own surprises. One group of first graders would guess until it got just one step away, which the children could solve. As they played, they moved on to making sense of "two away" and then of three.

Most second graders enjoyed the one-to-ten game. Some counted; some practiced their facts. Children who mastered this game tried larger oceans. For some this became a game of successive approximation. A child might guess 23 and be told he was 48 away. His next guess might be 50. Children would work themselves closer until they could figure out the problem.

For some children, the challenge became catching the fish in the fewest number of guesses. To my delight, *Catch the Fish* became an estimation game that helped these children get a clearer sense of the numbers from one to 100. More accomplished second graders took it as a mental arithmetic game and tried to solve the problems in their heads.

> *Kindergarteners played and worked until they figured out effective counting strategies; older children polished estimation skills.*

A big surprise came when some second graders tried the one-to-500 ocean. They guessed 83; the computer told them that they were 253 steps away. What did they guess? Two hundred and fifty-three! The same strategy as the five year olds. This made me wonder whether some repetitive cycle of mastery occurs as children are exposed to larger and larger numbers. Perhaps further observation of children's experimentation might suggest ways to support a child's natural developmental sequence.

Finally, the third graders loved using the large numbers. Some used *Catch the Fish* as an estimation game, some as a mental arithmetic challenge. Still others used pencil and paper. For all these children, going fishing became a meaningful mathematical activity.

Ricky Carter teaches computer literacy at Lesley College, Cambridge, Massachusetts, and is a graduate student at MIT.

The Catch the Fish Program

Catch the Fish is written for an Apple II microcomputer but can easily be modified to run on other computers.

```
100  HOME
110 A = 0
120  PRINT  TAB( 13);
"CATCH THE FISH!!!"
130  PRINT : PRINT :
PRINT "IN THIS GAME Y
OU ARE THE CAPTAIN OF
"
140  PRINT "A BOAT. Y
OU MUST TRY TO:"
145  PRINT
150  PRINT  TAB( 12);
"CATCH THE FISH!!"
155  PRINT : PRINT "H
OW BIG AN OCEAN DO YO
U WANT?"
160  INPUT "10,20,50,
100,OR 1000?";S
161 F =  INT ( RND (1
) * S)
162  IF S = 10 OR S =
 20 OR S = 50 OR S =
100 OR S = 1000 THEN
 GOTO 190
180  PRINT : PRINT "P
LEASE CHOOSE EITHER:"
: GOTO 160
190  IF F = 0 THEN  G
OTO 161
200  PRINT : PRINT "H
ERE ARE THE POSITIONS
"
210 A = 0
220  FOR I = 1 TO 10
230  IF I > 1 THEN  G
OTO 250
240  PRINT S / 10;: N
EXT I
250  PRINT  TAB( 4 *
(I - 1));(S / 10) * I
;
260  NEXT I
300  GOSUB 2000
320  PRINT
400 B =  INT ( RND (1
) * S)
410  PRINT "THERE IS
A GIANT FISH HIDING I
N THE SEA."
420  PRINT "WHAT POSI
TION DO YOU WANT (1-"
;S;")";
430  INPUT G
435  IF G = 0 THEN  G
OTO 450
440  IF G <  = S THEN
 460
450  PRINT "CHOOSE A
NUMBER FROM 1 TO ";S:
 GOTO 420
460  HOME
500 Q =  INT (G / (.1
 * S))
502  IF Q = 0 THEN Q
= 1
505  PRINT "HERE IS Y
OUR POSITION:"
510  PRINT  TAB( 4 *
Q);"<B>"
520  GOSUB 2000
525  FOR I = 1 TO 500
: NEXT I
527  INPUT "HIT 'RETU
RN' TO FISH: ";X$
530  HOME
540  PRINT "DROP YOUR
 HOOK"
541  PRINT  TAB( (4 *
 Q) - 1);"<B>"
545  GOSUB 3000
550  FOR I = 1 TO 100
: NEXT I
560  FOR I = 1 TO 3
570  PRINT  TAB( 4 *
Q);"!"
580  NEXT I
590  GOSUB 3000
600  IF A = 1 THEN 15
00
610 D = G - F
620  IF D = 0 THEN  G
OTO 1400
700  PRINT "YOU MISSE
D!"
710  PRINT "YOU ARE A
T ";G
```

Please turn to page 18

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Cont. from page 17

```
720  PRINT "THE FISH
IS "; ABS (G - F);" A
WAY!"
730  GOTO 420
1400  GOSUB 4000
1410  VTAB (6)
1420  PRINT  TAB( 4 *
 Q );"<FISH>"
1430  VTAB (15): PRIN
T
1440  PRINT "***YOU G
OT IT!***"
1445  PRINT : PRINT
1450  PRINT "PLAY AGA
IN?"
1452  PRINT "TYPE '1'
 FOR YES"
1454  PRINT "TYPE '2'
 FOR NO"
1460  INPUT "AND  '3'
 IF YOU WANT TO CHANG
E THE SIZE OF YOUR OC
EAN.";Z
1470  IF Z = 3 THEN
HOME : GOTO 155
1480  IF Z = 2 THEN 1
0000
1490  IF Z = 1 THEN
HOME : GOTO 200
1491  PRINT "PLEASE C
HOOSE 1,2, OR 3.": GO
TO 1450
2000  PRINT : FOR I =
 1 TO 40
2010  PRINT "-";
2020  NEXT I: PRINT
2021  PRINT : PRINT :
 PRINT : FOR I = 1 TO
 40
2022  PRINT "-";
2023  NEXT I: PRINT
2030  RETURN
3000  FOR I = 1 TO 40

3010  PRINT "-";: NEX
T I: PRINT : RETURN
4000  FOR I = 1 TO 50
0: NEXT I: RETURN
10000  PRINT : PRINT
: PRINT "SEE YOU LATE
R"
10100  END
```

On Line

Cont. from page 7

education," said G. Gregory Smith, executive director of the foundation. "We have received over 500 applications for grants and are pleased by the high quality of the proposals. The applicants have demonstrated to us that there is a genuine need for microcomputers at all levels of education."

Bell & Howell, Inc., a leading supplier of educational equipment, is, along with Apple, a major contributor of financial support and equipment to the foundation. Other companies donating equipment or services to the foundation are ABW Corporation; Corvus Systems; Heuristics, Inc.; Integral Data Systems, Inc.; Interactive Structures, Inc.; M & R Enterprises; Mountain Computer, Inc.; Personal Software; Stoneware Microcomputer Products; Videx Corp. and Regis McKenna, Inc.

A total of 37 microcomputer systems were awarded in the grant cycle to 26 recipients, bringing the total number of systems awarded to date to 123. The six grant recipients for primary and secondary school projects were:

Elementary and Junior High Schools

Spelling: One system valued at $4,994 to develop a program to help improve the spelling performance of sixth-, seventh- and eighth-grade students. Awarded to Lexington Public Schools, Lexington, Massachusetts, Dr. Frank DiGiammarino, developer.

Probability and statistics: Two systems valued at $4,830 to develop probability and statistics simulation programs for junior high school students. Awarded to Platteville Middle School, Platteville, Wisconsin, Dr. Kenneth R. Kundert, developer.

Language arts: One system valued at $2,955 to develop a language arts program to teach beginning computer awareness in grades four through six. Awarded to Pittman Learning, Inc., Belmont, California, Judy Goodnow, developer.

High Schools

Writing skills: Two systems valued at $5,940 to develop programs to teach idea-producing skills and writing skills to students studying remedial English. Awarded to Sumner High School, Sumner, Washington, Karyl Monaco, developer.

Personal finance: One system valued at $3,320 to develop a set of programs to allow simulation of personal finance activities by high school consumer education students and instructors. Awarded to Rick Thomas, Junction City, Oregon.

A Chance to Help the Handicapped

Putting computer technology to work for the benefit of handicapped individuals is the goal of a nationwide contest being sponsored by Johns Hopkins University's Applied Physics Laboratory, the National Science Foundation and Radio Shack.

The sponsors are soliciting ideas for computer aids for deaf, blind, mentally retarded or learning disabled persons, for patients with neurological or neuromuscular conditions, or for the orthopedically handicapped. A $10,000 grand prize, as well as 100 smaller prizes, will be awarded. Professionals, students and computer hobbyists are all welcome to submit their ideas. For entry applications and further information, please write: Personal Computing to Aid the Handicapped, Johns Hopkins University, P.O. Box 670, Laurel, MD 20810.

Our Readers Report

by Katharine G. Cipolla

One of the most satisfying developments in the life of any service-oriented publication is the beginning of a dialogue between itself and its readers. Such an exchange keeps the publication attuned to its readers' needs and to developments in its field in a way that even the best reporting can't duplicate. Therefore, the *Classroom Computer News* staff, especially this writer, was pleased when a recent request for information about computer applications in libraries and media centers brought reports of several interesting and innovative projects. We'd like to share these with you, in hopes of expanding the dialogue even further.

Computing Librarians' Task Force Formed

Jim Deacon reports from Minnesota that the Association for Computing Machinery (ACM) now has a Computers and the Media Center Task Group, of which he is chairman. The Association of Computing Machinery (the name is challenged regularly as outmoded, but the initials are too well known to alter) is a society of over 40,000 computer professionals that has a structure seemingly as complex as the federal government's. A little background to place the task group in its proper context:

ACM's many subgroups fall into two major categories. Some are special interest groups, such as the Special Interest Group for Computer Uses in Education and the Special Interest Group for Personal Computing, that publish newsletters and exchange information relevant to their special interests. Others are more task-oriented. One of these, the Education Board, is concerned with all aspects of computer education. It governs the Curriculum Committee on Computer Education (C^3E), which makes recommendations on computer science curricula. In true hierarchical fashion, C^3E begat the Elementary and Secondary Schools Subcommittee (ES^3, concerned with all instructional aspects of computers at the pre-college level), which begat the Computer and the Media Center Task Group.

The task group was formed in November 1979; as of May 1980, it included over 90 members in 23 states and Canada (and one in South Africa!). The group publishes a quarterly newsletter as a forum for its members to share ideas, information and software. It has also surveyed its members to compile information about equipment and software that libraries and media centers are using.

The survey revealed some interesting software projects. Most members are working on administrative applications including film cataloging and booking, circulation and inventory, shelf listing and purchasing. Some are branching into production of bibliographies, library orientation and bibliographic instruction. Current and planned projects include using a microcomputer for circulation control of a large (12,000+ titles) library. This system will include a hard disk drive or a series of floppy disk drives, coupled with bar codes read by a wand (a wand is now available for the Apple II). Another project will use an Apple II for library orientation for fifth, seventh and tenth graders. Many task group members are willing to share their software.

The Computers and the Media Center Task Group is anxious to hear from others interested in using computers in libraries and media centers. For more information about the group's activities, contact: Jim Deacon, Chairman, Computers and the Media Center Task Group, Independent School District #252, 820 East Minnesota Street, Cannon Falls, MN 55009.

Overdue Notices Plus

Joseph H. Ward, Jr., librarian at the Adrian C. Wilcox High School in Santa Clara, Calif., reports another successful application. He sent *Classroom Computer News* a reprint of his article "Microcomputer Generated Overdue Notices." The title is too modest. A computer program that writes only overdue notices would itself be a boon to beleaguered librarians, but this program also keeps track of circulation patterns for the annual report, tabulates the use of special "tagged" titles, stores data needed for effective use of the collections budget and probably makes justifying increased collection budgets easier. The program runs on a TRS-80 Level II with 48K memory, a mini-diskette drive, a printer and two student assistants (a crucial component). The students key the daily circulation into the computer and subtract the daily returns; in due time, the program generates the overdue notices. Meanwhile, the circulation data are recorded on a storage diskette. to be used later for compiling the special lists and reports.

Ward's article, which appeared in *CMLEA* (California Media and Library Educators Association) *Journal* (v. 3, no. 2, Spring 1980, pp. 12-14) also shares ideas on acquiring a microcomputer. (The entire Spring 1980 issue of *CMLEA Journal* was devoted to microcomputer applications.) Ward welcomes inquiries about his work; he says that this is only one of six library management programs that use the data-handling capabilities of a small system to organize his library. Write to him at the Adrian C. Wilcox High School, 3250 Monroe Street, Santa Clara, CA 95051.

Personnel Development

In "Personal Microcomputers in the Library Environment" (*Journal of Library Automation,* v. 13, no. 3, September 1980, pp. 196-7), Frederick J. Raithel of the Mid-Missouri Library Network reports on an innovative, microcomputer-based personnel development program the network has developed. Their program, which is used by their own and participating libraries' staffs, offers a Q & A quiz on library references, an electronic newsletter and demonstrations of the potential of the microcomputer for alphanumeric sorting.

The program runs on a 16K host microcomputer that is connected via the telephone lines to remote terminals in the libraries. "It is too early to measure the effectiveness of computer-assisted staff development in libraries," writes Raithel, "but there is an underlying confidence that the use of personal computers in libraries for personnel orientation represents a bold and exciting venture in the synergism of personal computing and libraries."

Please share your experiences with microcomputer applications in libraries. Send information to Katharine G. Cipolla, c/o Classroom Computer News, *P.O. Box 266, Cambridge, MA 02138.*

Katharine G. Cipolla is the media services librarian at Barker Library, Massachusetts Institute of Technology, Cambridge, Mass.

START

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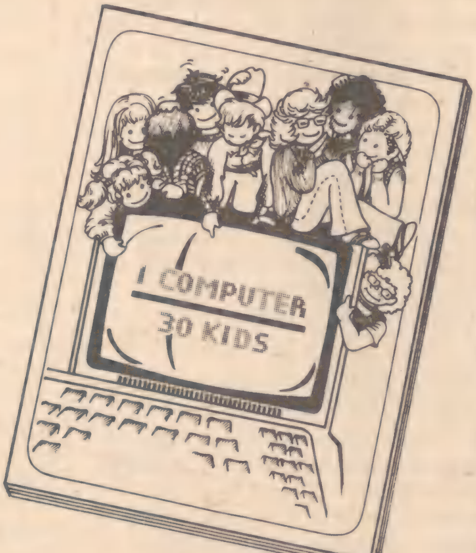

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Seymour Papert

Cont. from page 11

what's happening, find it a tremendous relief that the kids can go along without them and then begin to play their real role of being able to help out where there's real difficulty.

Have you thought about whether the poor, black people, Third World people are really going to be able to make the Turtle and the Turtle's descendants their own, or whether the Turtle is going to end up being a tool in the hands of the rich?

Yes, I think that's the central question. Will the computer culture continue to be made only by a particular subset of the population? I don't know how it will work out, but it's very clear that the most likely scenario is that the computer culture will continue to be made by engineers, and as it happens in America, *white* engineers, so that this simply becomes more exaggerated, particularly in the education world. The computer has taken a certain shape and those who like that shape come to it, make it more so. Those who don't like that shape move as far as possible away from the computer, won't touch it. Can we reverse that? I don't know. What I worry about most is how to do it. And so, for example, in the New York City Public School Project we didn't allow anybody who had had previous involvement with computers to be part of it. We wanted to bias it as far as possible toward training the sort of people who didn't know they had anything in common with computers. And most of them who came in had no idea what they were coming into. What they eventually made of the computer has nothing to do with previous ideas they had about what computers are.

I'd like to take seriously the idea that the Turtle is not the answer; it's only an object to think with about other objects. It must reflect a *certain* culture, in all sorts of ways—in this case, a mathematical culture. The question is whether the computational objects that will be invented in years to come will come from these other subcultures. So, I think the dynamic is whether we can create conditions which will allow people, such as those you mentioned, to become creative in the area of molding computational objects.

I'd like to make more flexible computer systems so that the people using them can have more freedom in molding them to what they want them to be.

Peter Kelman is assistant professor of education at Dartmouth College, Hanover, New Hampshire.

How Does the Computer Remember?
Part III

by Lloyd R. Prentice

You'd think that you would be able to get away with but one kind of memory in your PET, Apple or TRS-80—but 'tain't so. Every well-dressed computer needs *three* kinds of memory: Random Access Memory (RAM), Read Only Memory (ROM) and some form of mass storage (disk or tape).

Previously, we used the metaphor of post-office boxes to describe Random Access Memory. We said that the central processor could write binary information into or read it out of various locations in RAM. Since each memory location has a unique address, the processor easily keeps track of what's stored where. (See "When the Kids Ask . . . ," p. 17, *Classroom Computer News*, vol. 1, no. 3)

Volatile Memory

RAM is an essential part of a computer, but it has drawbacks: it's relatively expensive and, in some cases, it forgets what it was supposed to remember when the power is turned off. Engineers say that such memory is *volatile.*

The RAM in most small computers is indeed volatile. Imagine your angst if you had to start over from scratch because a milk truck hit a power pole outside your house just after you'd spent two hours typing a 1000-line program into your Atari. Now you know why small computers need more than one kind of memory.

Read Only Memory is less expensive than RAM and it doesn't forget easily. But the processor can only read out of ROM. It can't write information in. So what good is ROM? With ROM at hand, the processor can look up important information or programs at any time, even when it wakes up in the morning after a long night without power.

ROM is used in small computers to store programs that are used frequently by the processor, such as the programs that allow the processor to read the keyboard and write out to the video display. These programs, and others necessary to make the computer behave like a computer, are called, collectively, the operating system and are usually put into ROM at the factory.

Mass Storage

But you're still in for disappointment if all you have in your computer is RAM and ROM. RAM gets flaky when a youngster trips over the power cord, and the processor can't write into ROM. So what do you do with the 1000-line program you've typed into your Atari? Store it on disk or tape. Why? Because disk or tape storage is relatively permanent. Once your program is tucked away in mass storage, you can safely turn off your computer without worrying about losing your program. Moreover, mass storage is inexpensive compared with RAM. Suppose you want to store a 12-page short story. Depending upon your computer, it will cost $30 to $300 for sufficient RAM to store it, that is, for some 16,000 bytes. Memory capacity is measured in bytes; one byte stores one alphabetic character.

On the other hand, you can easily store four or more 12-page short stories on a fifty-cent cassette tape or on a three dollar floppy disk. The process is little different from recording Blondie on your Sony, only your machine is recording binary data rather than music. Clearly, one reason that a tape or disk system is called mass storage is that it can store a lot of information relatively cheaply. It's disadvantage over RAM is that it is much slower. Whereas the processor can write a character out to RAM in less than two-millionth of a second, it might take a twelfth of a second to write the same character to tape, or one-thirty-thousandth of a second to disk. You might not think that it makes much difference at these speeds, but when you have lots of characters to save, waiting for a computer can get to be a drag.

RAM gets flaky when a youngster trips over the power cord, and the processor can't write into ROM.

So, each form of memory has a place in your computer. Information can easily and quickly be written into and read out of RAM, but RAM is expensive and volatile. ROM is nonvolatile, less expensive than RAM, as fast as RAM, but a one-way street as far as information flow is concerned. Magnetic tape and disk storage are quite inexpensive, nonvolatile, can be written onto and read quite easily, but are relatively slow. Yet put these three forms of memory into one computer and you have a powerful system. ROM provides programs and data to the processor the instant power is on. RAM provides responsive working memory for the processor—allows the processor to work at top speed. Mass storage provides a secure and inexpensive repository for data and programs.

Tape vs. Disk

A word on the difference between tape and disk.

The tape system on most modern microcomputers is just a cassette tape recorder. It can cost less than $60, is widely available, is familiar and uses an inexpensive recording medium, the Phillips cassette. But the rate at which information can be stored and read is quite slow, and a human must push the buttons to make it record and play back.

A disk system is like a record player that uses a magnetic disk. The computer can turn the disk drive on or off and move the record/playback head across the radius of the disk. Rather than having to search a length of tape to find particular data, the computer can direct the record/playback head in the disk drive to go to just the right spot, which makes the disk system significantly faster and more versatile than tape, but at a price: $500 and up.

Memory is what makes the difference between a computer and a calculator, and one law governs it: however much memory your computer may have, there's never enough for the next program you want to run.

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NEW PRODUCTS

Products briefs are written from manufacturers' announcements.

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A free, 1981 products catalogue is available from Microphys Programs, 2048 Ford St., Brooklyn, NY 11229; 212/646-0140.

Five-in-one Algebra Package

More Algebra, a set of five computer-assisted instruction programs for the Commodore PET/CBM computers, is now available from Tycom Associates. The programs, which are designed to provide review practice in solving several common types of algebra problems, complements *Tycom Algebra,* an earlier release.

The five programs are: "Slope," a review of graphing, slope and distance between points; "Simul," a review of simultaneous linear equations in two variables; "Quad," quadratic equations that may be solved by factoring; "Disc," the use of the discriminant to determine the nature of the roots of a quadratic equation; and "Comp," a review of the Quadratic Formula that provides quadratic equations with complex roots for the user to solve.

All programs automatically keep score and, when a user is finished, tell the user how many problems he or she attempted and display a final score.

More Algebra is available as a single cassette tape or as a set of five tapes. For further information, contact Tycom Associates, 63 Velma Avenue, Pittsfield, MA 01201.

Milliken's Revised Math Sequences

Milliken Publishing Company's revised *Math Sequences* package is now available for the Apple II Plus (48K) computer. The 12-diskette package provides a comprehensive, objective-based curriculum for students in grades K-8. The package includes the following sequences: Number Readiness, Addition, Subtraction, Multiplication, Division, Laws of Arithmetic, Integers, Fractions, Decimals, Percents, Equations and Measurement Formulas. Students work at their own pace toward mastering specific skills while the computer continually monitors their performance and provides immediate feedback and reinforcement.

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The fall 1980 edition of *The Science Fair Story of Electronics* is available for free distribution to teachers, students, youth groups and other science enthusiasts.

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The Science Fair Story of Electronics is available without cost from participating Radio Shack stores and dealers, nationwide, or by sending a card or memo to Radio Shack, Educational Comic Book Program, 1300 One Tandy Center, Fort Worth, TX 76102, Attention: Bill Palmer.

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Software Directory

School Microware is a quarterly software directory serving the rapidly growing community of pre-college instructional computer users. It covers instructional microcomputer software available for the three micros most widely used in education: the Radio Shack TRS-80 (Model I), the Commodore PET and the Apple II.

The first issue of *School Microware* (September 1980) featured over 500 instructional programs and packages available through 45 suppliers. Quarterly updates will be published in December, February and April. For further information, contact *School Microware,* Dresden Associates, Dept. CCN, P.O. Box 246, Dresden, ME 04342.

The Game of Life

by Paul Shapiro

Wondering what to do with your gifted math or science students? Why not introduce them to the challenge of scientific modeling through Conway's Game of Life. It's easy, fun and surprising. Clip this article and give it to your students.

Generally, a mathematical model is a representation of some real-life process, expressed in mathematical form (such as a set of related equations) or in algorithmic form (such as a computer program). Usually the model is by necessity a simplification of the actual process, since real-life processes tend to be highly complex. One advantage of embodying the model as a computer program is that we can run the program and thus simulate the process being modelled. By varying certain features of the program, we can learn something about the relationships between the components and the overall structure of the process. In addition, if the output does not sufficiently coincide with observed reality, the model can be revised and improved.

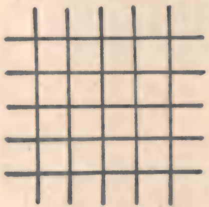
It is also possible to model a purely abstract process. We don't often see this done. After all, if someone asked you to describe some abstract process, what would you say? However, many games start out as purely abstract processes. For example, tic-tac-toe or checkers are abstract from the point of view that they represent no real-life process. Occasionally, it turns out that an abstract process represents a real-life process either by accident or by design. The model described below is one such abstract game that in some ways actually represents life itself.

The Game of Life

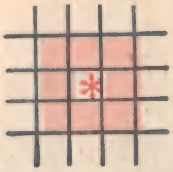
The Game of Life was devised by John Conway, a mathematician at the University of Cambridge, and made popular by a series of *Scientific American* articles written by Martin Gardner. Ever since the first article appeared in October 1970, hundreds of mathematicians throughout the world have become fascinated with the model and have been exploring its properties.

The game consists of following the successive generations of a particular imaginary type of cellular life-form. The life processes of these cells are represented by the following mathematical model, which captures several properties common to all life-forms.

(1) *World*—Cells live on an infinite two-dimensional plane of squares (like an infinite checker-board except that all squares are identical).



(2) *Neighborhood—Each* square has eight "neighbor" squares. In the diagram below, the *neighbor* squares for the square with the asterisk (*) are colored in.



(3) *Survival*—A cell (always represented by a *) that is living in generation n, will remain living in generation n+1 if and only if it has exactly two or three living neighbors in generation n.

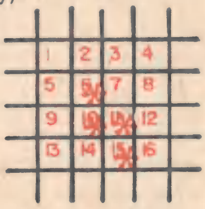
(4) *Death*—However, in all other cases the cell dies. Specifically: if it has zero or one neighbors it dies from isolation. If it has four, five, six, seven or eight neighbors, it dies from overpopulation.

(5) *Birth*—If a square is empty during generation n, a living cell will be born into that square during generation n+1 if and only if that square had *exactly three* (no more, no less) living neighbors during generation n.

The only trick is to remember that all survivals, deaths and births occur *simultaneously*, and so the simplest way to keep the "bookkeeping" straight is to have two separate copies of the world—one for the old generation and one for the new one you are forming. For each square in the old world, decide what its state will be next time, and mark this down *in the corresponding square* in the new world.

The game is played simply by picking some initial starting pattern and watching the development of some very interesting, and often beautiful, patterns of symmetry. However, the player must be extremely careful because mistakes are easy to make.

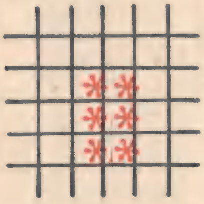
As an example, we will trace three generations of the following initial pattern (we have numbered some rows and columns for reference purposes only):



Following the rules of our model:

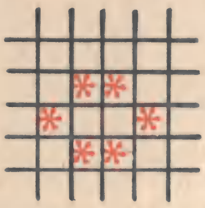
- No births will occur in squares 1, 2, 3, 4 or 5 because none has *three* living neighbors.
- The cell in square 6 will survive because it has two living neighbors (10 and 11).
- A birth occurs in square 7 because there are three living neighbors (6, 10 and 11).
- No birth occurs in squares 8 or 9.
- The cell in square 10 survives because it has three living neighbors (6, 11 and 15).
- The cell in square 11 survives also because it has three living neighbors (6, 10 and 15).
- No birth occurs in squares 12 or 13.
- A birth occurs in square 14 because there are three living neighbors (10, 11 and 15).
- The cell in square 15 survives because it has two living neighbors (10 and 11).
- No birth occurs in square 16 because it only has two living neighbors.

During this process, we have been filling in a picture of G1, and the end result is:



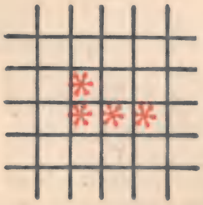
Exercise One

Using pencil and paper, carefully compute G2, the next generation for this game society of cells. If you do it correctly, you will find that G2 is the pattern which Conway calls the "beehive":



Exercise Two
Now compute G3. If you are again careful, you will discover that G3 is identical to G2. Why does Conway call the beehive a "still-life"? If you are not sure, think about G4, G5, G6 . . .

Exercise Three
Using pencil and paper, compute G0, G1, G2 and G3 for the initial pattern below:



If you do it correctly, G3 should look familiar to you.

Computer Project One

By now you've no doubt noticed that with pencil and paper, this game is extremely slow, and mistakes are all too common. If we ever hope to look at more than a few patterns, we're going to have to turn to the computer for help.

Write a computer program that simulates *Life* for *any* given initial pattern, and which has the following features:

(1) Allow for as large a world size as your particular computer facility will permit (obviously an infinite plane is not possible in a finite memory). You will probably want to use array structures with two subscripts (row and column).

(2) Whatever world-size you are limited to, make sure your program doesn't try to allow births outside your world, even though these *would* occur on an infinite plane.

(3) Make sure your algorithm allows all survivals, deaths and births during a given generation to occur *simultaneously,* as discussed above.

(4) Allow the user to input the initial pattern in a convenient format, such as pairs of (row, column) coordinates.

(5) Make your program efficient and your output as close to the format of the pictures above as possible.

Once you've designed your algorithm and written your program, debug your program by running it on the following initial G0 pattern. Carefully check your output vs. the results below:

```
G0
 *
***          G1

             ***
             ***
G2            *
 *
* *

***          G3
              *
              *
             * *
              *
G4            *
***
* *
***
             G5
               *
              * *
             *   *
              * *
               *
```

Warning! Depending upon the world-size you are limited to, certain "large" patterns may grow differently than they would on an infinite plane. If the society of cells above fits inside your world-size, however, you will notice an interesting cyclic pattern beginning at G0, which Conway calls "traffic lights."

Project Two

When you have thoroughly debugged your program, or if you are using an existing *Life* program, the real fun comes in thinking up initial patterns and watching them grow. Interesting situations to watch for are:

(1) Other "still-life" societies (like the "beehive")

(2) Other "cyclic" societies (like the "traffic lights")

(3) A society that lives for an extended period of time without dying, becoming still or cycling.

Bring your findings to class for comparison and discussion.

Optional Project Three

Find copies of the October 1970 and/or Febrary 1971 issues of *Scientific American* and read Gardner's articles on *Life.* You may want to run your program on some of the societies he describes, such as: diagonal chains, the R pentomino, the Latin cross, the cheshire cat. Your school library may subscribe to the magazine. If not, the public library near you will certainly have it available.

Optional Project Four

Try to think up changes in the model (and your computer program) that will drastically alter the life patterns of the cells, i.e. by modifying the rules for birth or death or both. Based upon your experience so far, try to come up with sets of rules that will lead to more populous societies, or more sparse societies or societies that are less symmetric than those of *Life.* The range of possibilities is very large. Bring your findings to class for comparison and discussion.

Optional Project Five

Make some major modifications in your computer program to make it more *general,* by allowing the user to specify the particular model he wants to investigate. For example, you might have your program begin by posing the following questions to the user:

How many neighbors for survival?
How many neighbors for birth?

Then, if the user answered two, three, for the first question and three for the second, your program would follow the rules of *Life.* But if he gave other answers, the program would simulate for him some other model he wants to investigate.

Optional Project Six

Is there any way you can streamline your program so that you can enlarge the size of the world it currently handles?

Optional Project Seven

How might you alter the general concept of "neighborhood" so that entirely different models could be tested? How would your computer program have to be changed in order to simulate these new models?

Optional Project Eight

You can place two different types of life forms in the world and let them interact with each other subject to the standard rules for *Life.* A competitive *Life* game, *Life-2,* has been devised which allows two players to put three life forms on the board per move and to try to eliminate the opposing player. Class members may play this game as individuals or as teams. Are there any playing strategies that can be rigorously stated? Can two good players go on forever with no winner?

Paul Shapiro is coordinator of educational computing services for the Newton Public Schools, Newton, Mass.

BOOK REVIEWS

Mindstorms: Children, Computers, and Powerful Ideas
by Seymour Papert
Basic Books, N.Y., 1980

Seymour Papert's work with LOGO has been reported on and speculated about for the past few years. Here, for the first time, is a chance for a broad audience to get some notion of what he and a cast of hundreds have been doing and how it purports to change the face of education.

Many current computer languages help children to learn content in specific subject areas or to master specific programming techniques. In contrast, LOGO focuses on the child's thinking processes. Influenced by Papert's work with Piaget, LOGO deviates from the "usual" languages in both its goals and its form. For this reason, it has been highly controversial. Papert's work is not about computer-assisted instruction; it is not about teaching children to program computers; rather, this journey through LOGO tells how children can come to *know* computers through working with and through them.

Over the past decade, at the Artificial Intelligence Lab at M.I.T., Papert has worked to make a language powerful enough to facilitate both children's thinking and thinking about thinking. He proposes the "Turtle" as "an object to think with." Children use simple commands to move the Turtle over either the floor (in the case of "floor Turtle") or the monitor ("screen Turtle") and so create "programs" that make Turtle draw a variety of pictures and perform other child-developed feats.

Very young children have worked successfully with the Turtle, and the descriptions in the book suggest that elementary school children would be ideal candidates for this introduction to powerful thinking—or "mindstorms."

Papert is a skilled and sometimes elegant writer. His foreword evokes his childhood experience of becoming fascinated with gears, learning everything about them through tinkering, and later using them as an image system in most mathematical situations. In this he suggests that learning can become passionate ("I fell in love with the gears"). And we can hear Papert's wish tor LOGO to provide a similar passionate link to computers. Through LOGO, Papert means to give children a system of experimentation that is child-controlled, in which children speculate about the behavior of things and about ways to explore and find out.

Surely it is in the sense of learner-as-tinkerer that the stuff of "real" learning lies. With LOGO, children are in control of the computer and their tasks throughout. A very few words enable them to get started; from there they follow their own interests as they begin to find more to express and more complex ways to combine routines and procedures. They debug, develop routines, design procedures and superprocedures.

Tapping the Unconscious

LOGO seems, initially, simply a way to draw and to move images about on a monitor. The governing principles, however, are very profound; they underlie all of programming. Papert aims to tap into the mathematical unconscious—to move deep under the surface of arithmetic to the world of intuition, power and beauty, which school math generally avoids.

Papert builds his work on "mathetic" principles—those that govern all learning. The ideas a child is learning should be continuous with the rest of the child's experience, should be powerful in personally meaningful terms and should be synchronous with the rest of the child's life experience. These principles are certainly resonant with "holistic" learning theories: one must be able to grasp the blocks of the idea-building systems, must want to and must be able to make meaning of it. The exciting development is that Papert has created a whole new language for learning. With computers, perhaps the least likely material, Papert has made a warm and powerful system for thinking about thinking.

> *Papert aims to tap into the mathematical unconscious—to move deep under the surface of arithmetic to the world of intuition, power and beauty*

Papert's book is clear and comprehensible, for the most part, and may become one of the most important contributions to education literature in the 80's. By placing the LOGO learner in the center of the stage, firmly in control of the work-to-be-done, and the LOGO teacher in a generally unaccustomed consultant role, Papert introduces some important changes in education.

Papert intends his system to revolutionize schools, and the widespread use of LOGO could certainly alter the usual classroom setup. Work with LOGO could also become an add-on, however, and in that become perverted from the original point.

The book's appeal and power may be diluted by readers' unfamiliarity with LOGO, although copious illustrations help minimize that problem. Papert has a habit of referring to people and books that are not included in his chapter notes. One then turns to the bibliography to find further references, but finds no bibliography. This may create a problem for those who want more reading. Papert's Piaget is occasionally other than the Piaget many of us recognize. This would be easier to swallow if Papert did not invent words like "Piagetionly-conserved" (sic) to describe ideas. There are sprinklings of sexism and elitism as well.

Despite its drawbacks, however, *Mindstorms* is one of the most sensitive, interesting, visionary books written about learning the past few years.

In short, LOGO is a powerful, joy-filled language with infinite promise for children and adults who want to become passionately involved with extremely powerful ideas.

—Rebecca B. Corwin

Rebecca B. Corwin is an assistant professor at Lesley College, Cambridge, Mass.

New Books

Please Note: New Books have not been reviewed; announcements are written from publishers' releases.

Professional Development and Educational Technology

Association for Educational Communications and Technology (AECT), Washington, D.C. 1980. $15 (Nonmembers); $13.50 (AECT members). (Hard Cover)

Proceedings from the Professional and Educational National Technology Conference, January 1980, sponsored by AECT. The papers stress successful applications in telecommunications, computers and other electronic fields. Includes case studies; implications of the expanding use of technology in education and training; videodisc innovation projects; multi-media techniques; regional use of technology, and more.

For more information, contact AECT, 1126 Sixteenth St., N.W., Washington, D.C. 20036; 202/833-4180.

PET Software Specialists Science and Education **APPLE**

Microphys Programs

Microphys is pleased to announce the availability of its educational software for use in the Commodore PET/CBM and Apple/Bell & Howell microcomputers. These programs have been successfully employed in **Chemistry, Physics, Calculus, Mathematics, English Vocabulary** and **Spelling** classes on both the high school and college levels.

The programs are supplied on C-10 cassettes and are accompanied by complete instructions so that even those with little or no computer experience may immediately utilize the software in their classrooms. Each cassette retails for $20 and may be obtained from leading computer dealers or directly from Microphys.

Each **Physics, Chemistry, and Vocabulary** cassette has both a computer-assisted and individualized-instruction program recorded on opposite sides of the cassette. The **CAI program** guides the student through a series of quantitative questions; the student interacts with the computer and receives immediate evaluation of his responses and/or assistance when needed. The **I/I program** generates a unique set of problems for each student. The computer can supply answers so that the student may check his own work. If the teacher directs the computer to suppress these answers, the student completes his work at home and then feeds his results into the computer which grades his work, supplying the answers to those questions incorrectly solved by the student. **NOTE:** each time a particular program is run, a different set of numerical values is generated. In most instances, an entirely new problem is presented. The Mathematics and Calculus cassettes have only the individualized-instruction feature.

For those using disk drives, the programs have been coherently grouped and are available on diskettes. The price of each diskette is $180 which represents a considerable savings with regard to the individual cassette price.

Please write for the new Microphys Catalog which describes the complete line of educational software for use on the PET/CBM and Apple/Bell & Howell microsystems.

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Cont. from page 15

available for purchase. In addition to the thorough listing of Apple educational software, organized by grade level and curriculum area, the manual contains such useful information as very specific and clear instructions for setting up and accessing programs on an Apple II with a disk drive ("Remember," says Forman, "we were dealing with many people who didn't even know what a computer looked like") and specific information—including things to avoid—about purchasing software.

> *If the software isn't there, says a BC researcher, or if it's no good, you shouldn't have a microcomputer in the classroom.*

JEM also publishes a monthly newsletter, *Micro-Scope*, that documents the researchers' ongoing efforts.

"Putting microcomputers in the classroom is only the tip of the iceberg," says Wright. "It's at a very crude stage. All we've literally done has been to put a few machines out there, supported them, and we're seeing what's happening."

She sees the real potential of the microcomputer as a tool for helping students with special needs, such as deaf or partially sighted youngsters. "We're now working with some foundations and the school of the deaf in BC on the use of microcomputers to display the pitch of a deaf child's voice on the screen along with the satisfactory pitch, so that the child can learn to reproduce an acceptable sound. We're also looking at a program which will allow a partially sighted child to pick out a letter, word or sentence and enlarge it right there on the screen."

Wright's enthusiasm for these projects reflects the long term goal of JEM: enhancing the learning process through innovative technology.

Additional information on JEM Research can be obtained by writing Annette Wright, JEM Research, Discovery Park, University of Victoria, P.O. Box 1700, Victoria, BC V8W 2Y2.

Tom Lee, a media designer and consultant in Ontonagon, Michigan, is a regional contributor for Classroom Computer News.

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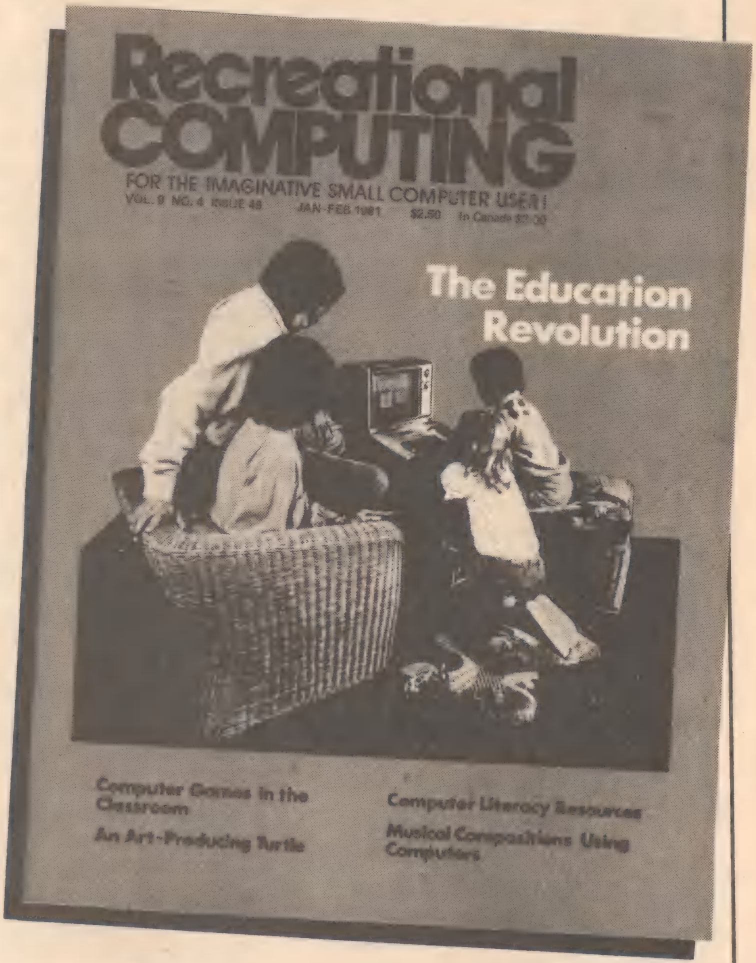
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Purchasing a Microcomputer

by Kenneth Temkin

Whether a school system intends to purchase one microcomputer or several, it should proceed deliberately, one step at a time. The first step comes at budget time, long before the school ever gets its equipment. Budgeting is determining exactly what you will need and how much it will cost.

A good idea is to organize a small committee of interested teachers, parents and, in some cases, students to outline the objectives for purchasing a microcomputer. Carefully review the software available for each machine you consider. Consult other schools and school systems that have already instituted programs. Rely on the most knowledgeable committee members to advise you about the hardware makeup that will best suit your school's needs. Visit your nearest computer specialty store(s) for a firsthand demonstration of the equipment. Be sure to pick up catalogs to take back to school. Before leaving, ask the dealer for a price list covering different modes of storage and video display and computer accessories. You should accumulate enough facts and figures to determine and justify your budget.

Writing Specifications

The next step, assuming the equipment budget will be approved, is to write specifications for the purchase of the computer system. The purchasing department will use the specifications in the form of a "Request for Quotation" or an "Invitation to Bid," depending on state and local laws. Through initial contact with vendors and by carefully describing the equipment and the services you desire, you can secure many extra benefits. Your specifications should include certain basic terms and conditions:

- Be specific in your description. State the manufacturer and model number of the equipment preferred, followed by the term, "...or approved equal."
- Note that all equipment must contain manufacturer's factory-installed parts.
- Make the seller responsible for delivery to the school, inside the receiving room (F.O.B. Destination Inside Delivery). In this way you avoid any direct shipping charges.
- Depending on the size of the order, request that the contractor make a complimentary one-time visit to assist in setting up and testing the system after delivery. Contractors should provide basic instruction in the proper maintenance of all equipment.
- Insist that the manufacturer's complete descriptive literature and guaranteed performance specifications accompany alternate bids.
- Leave space on the quotation sheet for the seller to fill in the manufacturer and model numbers of the equipment he is supplying with their unit and total costs. Inquire whether the seller offers any cash discount.
- Ask the seller to state his delivery schedule and warranty and to give the nearest field service location. These important factors can influence your final decision.

Lloyd F. Haug, manager, National Bid Department for Radio Shack, advises that, "The simpler the quote or bid, the more qualified the response." Keep your boiler plate (standard contract terms and conditions) within reason.

Soliciting Bids

After writing the specifications, you must decide from whom to solicit quotes or bids. This again depends on state and local laws, but be certain, in any case, to include local authorized dealers (especially those who worked hard to advise you), manufacturers that bid directly out of corporate headquarters (usually the nearest local dealer gets credit for any sale and is responsible for delivery, setup and warranty) and national distributors involved in education. Mail-order houses and department stores are questionable sources because they probably cannot give you the customer service and professional expertise you desire. Allow at least three weeks for responses to quotes or bids.

> *By carefully describing the equipment and the services you want, you can secure many extra benefits.*

The next step comes after the bid closing date, when you have to evaluate the proposals. Always remember that price alone does not justify the award. Open and read all the quotations or bids. Check the *lowest* one against your equipment specifications. Has the seller made any changes regarding delivery or service? Consider the delivery time, the warranty and the field service location. Be careful because many stores are not accustomed to reading specifications and miss important points. Get in touch with your first choice to be certain that no misunderstandings have occurred. When you are completely satisfied, make your final selection and notify the purchasing department.

You can use the waiting time between the purchase order and the delivery constructively. Read up on the operation of the new computer. Attend computer workshops. Look into software to purchase. Try some simple programming. Select a room or area that provides security for the new equipment. Have the electrical power checked and extension cords ready. Commandeer furniture. And what about supplies, such as cassettes, diskettes and printer paper? For a purchase involving several schools, distribute supply checkoff sheets to appropriate personnel.

The big day finally comes and the computer arrives. Try to be there in person to accept the boxes from the shipper. Look for signs of damage to the containers and note any on the shipping receipt before signing. If the purchase contract includes setup and instructions, leave the equipment untouched and immediately call the dealer to arrange for an appointment.

After the equipment is in place and running to your complete satisfaction, clear the purchase order for payment. Be sure to record all the serial numbers. Engrave names and identification numbers on the various pieces of equipment, being careful not to cause damage. Begin to think about maintenance; the warranty expires faster than you realize.

This procedure may seem tedious, but it will be to your advantage to follow it. In the end you'll feel confident that you've made the right selection and have gotten the most for your money.

Kenneth Temkin is the administrative assistant for support services for the Newton Public Schools, Newton, Mass. He is actively writing administrative software.

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LETTERS

Plain Talkin'

Your goal of publishing a magazine about computers which can be understood by those of us who speak only English is admirable. You'd be just the people to publish an article translating some of the terms and abbreviations which other publications assume to be common knowledge. Even their definitions are as technical as the term defined. You're my last hope for figuring out what a *baud* is supposed to be. Thanks.

Mike Stratton
Amherst, Massachusetts

Speak and Math in Class

Texas Instruments has recently introduced two new voice synthesized devices similar to *Speak and Spell* called *Speak and Read* and *Speak and Math.* We purchased a *Speak and Math* in the Ontonagon Area School District to see how it could support the mathematics curriculum. This device presents over 100,000 math problems on three levels of difficulty. So far it has had constant use by students from elementary to high school levels.

We would like to know your experiences with these devices. Write: Tom Lee, Special Projects, Ontonagon Area Schools, Ontonagon, MI 49953.

Tom Lee
Ontonagon, Michigan

Software Needed

We are in the process of developing an educational computer system at a comprehensive school for the physically handicapped. As a result, we are in need of courseware to augment our growing needs. We are willing to purchase or exchange software, or subscribe to software banks in order to get the desired materials. We're interested in any form of courseware or school management programming applicable to either elementary or secondary levels of normal, physically handicapped, mentally retarded or gifted students.

Please send any information to M. B. Burns, Director, CAI, Shrine School, 4259 Forest View, Memphis, Tennessee 38118.

M. B. Burns
Memphis, Tennessee

Misleading Micronews

We reported in our January/February Micronews column that PLATO materials may soon be available for the Apple microcomputer. This inadvertently lead some readers to assume that Apple itself is converting the materials, which is not true. The names of the individuals or firms working on the conversions have not been disclosed; currently, PLATO is available only on Control Data Corporation PLATO terminals.

CALENDAR

April

The 6th West Coast Computer Faire. April 3-5. San Francisco, California. Well over 165 speakers covering topics from computers in education to legal aspects of computing, plus more than 275 exhibits by manufacturers and distributors of low-cost systems for small business, school and home. Contact: Computer Faire, 333 Swett Road, Woodside, CA 94062; 415/851-7075.

Association for Educational Communication and Technology (AECT) Convention. April 6-10. Philadelphia Civic Center, Philadelphia, Pennsylvania. Over 300 sessions covering topics ranging from videodisc technology and microcomputers to updates on the copyright law. Contact AECT Convention Office, 1126 16th St., N.W., Washington, D.C. 20036; 202/833-4180.

May

National Computer Conference. May 4-7. McCormick Place, Chicago, Illinois. The biggest computer show of the year. One strand will concentrate on educational computing. Contact: AFIPS, 1815 N. Lynn St., Suite 800, Arlington, VA 22209; 703/558-3600.

Exploring with Computers in Vikingland. May 5-8. Leamington Hotel, Minneapolis, Minnesota. Annual AEDS convention. Will focus on six areas of using computers in education: Personal Management Skills; School Administration: K-12; Administration: Other Educational or Governmental Agencies; Computing in the Future; Computer Hardware: Micros, Macros, and Peripherals; Instructional Computing. Contact: AEDS '81 Convention Team, 2520 Broadway Drive, St. Paul, MN 55113.

Microcomputers in Education. May 15-16. Bloomington High School, 10750 Laurel Ave., Bloomington, California. Sponsored by Computer-Using Educators. Will cover subjects ranging from "How to Get Started with Microcomputers" to "Evaluating Microcomputer Systems." Free software exchange. Contact Forest Miller, Pre-registration Chairman, Coordinator of Math and Science, San Bernadino County Schools, 602 S. Tippecanoe, San Bernadino, CA 92415; 714/838-1728.

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Classroom Computer News

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MICRONEWS

• The combined retail value of microcomputer shipments to educational institutions will exceed one billion dollars from 1980 to 1985, according to Creative Strategies International, a California market research firm. The firm expects the share of the total market for microcomputers going to education to more than double over the period.

• Within five years, every freshman at Carnegie-Mellon University in Pittsburgh, Pa., will receive a microcomputer as part of the university's orientation program, reports Computerworld. The goal? Computer literacy for the fine arts major as well as for the computer programmer.

• SIGI, a widely used computer-based career guidance system developed by the Educational Testing Service, has been converted to run on a Radio Shack TRS-80 Model II computer. Radio Shack has announced an agreement with ETS to provide computers to colleges and universities licensed to use the system.

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Control Data Corporation's PLATO Basic Skills is the 3 R's delivered on a sophisticated computer system. How well does it work?

Dynamite! Super! No Way! What We Can Learn from CDC's PLATO

by Jeffrey Nilson

David is a sprightly sixth grader with wavy dark hair who is wearing a black sweat shirt with USA written across the front. He is sitting like a coiled spring in front of a Control Data PLATO computer terminal, doing a lesson on fractions.

"In school I'm having trouble with subtracting fractions with different denominators," he says.

After he finishes reviewing adding fractions with the computer, he chooses a tutorial on subtracting mixed numbers.

He touches the space marked "Tutorial," the terminal beeps, and the screen clears, leaving a message: "Wait a minute while I go find Clever." Clever is one of the characters that helps teach lessons in the Control Data Basic Skills Curriculum, which is what David is working through. Clever is a box with legs. In the middle of the box is a smile, which enables Clever's torso to double as its face.

At the beginning of the lesson, Clever shows how to subtract the bottom fraction from the one on top.

"Think 5 . . . Take away 1/3." Hopping back along a number line on the bottom of the screen, Clever shouts, "Look where I stop."

"I don't get it," David says.

The computer presents several examples, which David does parts of. He figures out how to subtract the bottom fraction as long as the denominators are the same.

"Super! Dynamite!" Clever exclaims. Then printing 7 - 3 1/4 in large numbers, the computer invites David to "try this one." David looks at the screen and folds his arms. "I don't know this at all,"

Please turn to page 4

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In terms of style, we are interested in news and feature stories that are fact filled, well-written and expressly directed toward our bright and critical readers. Stories should be lively, concrete and written for intelligent humans, with minimal use of computer or educational jargon.

News stories, as presented in the On Line section, run 300 to 400 words. Feature stories run from 800 to 2500 words. Clear, high-contrast glossy 8 x 10 photos are welcomed. Computer programs must be well-documented, thoroughly tested and machine printed. Use a new ribbon and clean white paper for program listings. Manuscripts should be typed and triple-spaced.

Classroom Computer News will pay $20 to $50 a printed page upon publication for reader-contributed stories, depending upon the quality of the manuscript and the amount of editing/rewriting needed. Contributors will also be given five copies of the issue containing their submission.

Send queries or manuscripts to Lloyd R. Prentice, Editor, *Classroom Computer News,* Box 266, Cambridge, MA 02138. Allow six weeks for acknowledgement. All submissions will be acknowledged, but only manuscripts accompanied by a self-addressed stamped envelope will be returned if not purchased.

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